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Appliances and Results in Exhaust Steam Circulation

BY JAS. A. DONNELLY

The use of exhaust steam for various purposes has become so general in the past few years that its efficiency is now conceded and its further growth depends upon improved control of the circulation and means for carrying it longer distances.

This need is felt the most when the conditions require the carrying of the steam a considerable distance in a horizontal direction, for here not only has it been difficult to economically and efficiently circulate the steam to the farthest point, but to be certain that the water of condensation will be properly brought back.

Exhaust steam led into a heating line from a pipe with an open back pressure valve has, or should have, a pressure not over 14.8 to 15 pounds absolute and a velocity of 100 to 150 feet per second. Considering the maximum vacuum practicable upon the return pipe as 26 inches, there is an available difference in pressure of about 13 pounds.

A system of piping for conveying this steam to the point of use and returning the water should be able to carry it further than has yet been attempted, provided this difference in pressure is properly utilized.

The amount of air present in the steam is a factor of some importance. At 32 degrees water will contain 2.4 per cent. of its bulk in air but this decreases rapidly as the water is heated until at 212 degrees it may be considered to have left the water practically free of air. It is, therefore, good practice if the utmost advantage is to be taken of exhaust steam as a heating agent that the water should either be heated in an open type feed-water heater or means provided for the removal of the air after the feed water has passed through a closed type. It is also probable that the pitting of boiler sheets at the water line would be much reduced by a more general adoption of this practice.

The lack of a comprehensive table as to the capacity of steam mains and corresponding drop in pressure for various velocities led to the making of the attached one from the Babcock formula (table, page 2):

It is believed that the velocities giving 1 ounce drop for 100 feet, run in several sizes are conservative for ordinary cases and that until further experimental data is provided for extremely large installations and very long runs, individual judgment and experience must be used.

The friction of elbows has been variously estimated, but it seems as if an allowance of 50 diameters in length for each right angle turn would be ample.

The table on page 3 gives some comparative results, using the Babcock formula, on the capacity of heating mains.

The Wolff table is taken from Carpenter and the Webster table from Monroe on Steam Heating.

If proper advantage is to be taken of the force available in maintaining a circulation of steam by reducing the pressure upon the return pipe, the following points are essential: The initial opening through all automatic devices must be of sufficient size that the air may be removed in a reasonable time; the automatic devices upon the drip points and radiators must have a large range of capacity that the water of condensation due to the heating of the apparatus may be withdrawn as quickly as possible; the thoroughfare through which the air was removed must be afterward closed so that steam is not passed into the main return; the difference in pressure between the two sides of the automatic water removing devices must be controllable in order to secure uniform operation; the temperature of the return must be reduced as soon as possible after passing the automatic device, in order that the main return may be covered

SIZES OF STEAM MAINS FOR DIRECT RADIATION.

SHOWING LOSS OF PRESSURE IN OUNCES FOR 100-FOOT RUN. THREE-TENTHS POUND CONDENSATION PER SQUARE FOOT PER HOUR.

Nominal Sizes of Pipe Used.

Velocity, ft. per sec.	10 Feet.		20 Feet.		30 Feet.		40 Feet.		50 Feet.		60 Feet.		70 Feet.		80 Feet.		90 Feet.		100 Feet.		110 Feet.		120 Feet.		130 Feet.	
Size of Main.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.	Drop.	Sq. Ft. Rad'n.
1 inch	.4	25	1.6	49	3.6	74	6.4	100	10.	124	14.4	148	19.6	174	25.6	198	32.4	224	40.	248	....	.....	....	.....	....	.....
1¼ inches	.29	39	1.16	77	2.61	116	4.64	155	7.25	194	8.28	232	11.4	271	14.72	310	23.5	350	29.	388	....	.....	....	.....	....	.....
1½ "	.2	56	.8	112	1.80	168	3.2	224	5.	280	7.2	336	9.8	392	12.8	448	16.2	504	20.	560	....	.....	....	.....	....	.....
2 "	....	....	.48	200	1.08	300	1.92	400	3.	500	4.32	600	5.88	700	7.68	800	9.6	900	12.	1,000	....	.....	....	.....	....	.....
2½ "	....	....	....	....	.75	465	1.34	620	2.1	775	3.02	930	4.1	1,085	5.37	1,240	6.8	1,395	8.4	1,550	....	.....	....	.....	....	.....
3 "	....	....	....	....	.56	669	1.00	892	1.56	1,115	2.25	1,338	3.06	1,561	4.	1,784	5.06	2,007	6.25	2,230	....	.....	....	.....	....	.....
3½ "	....	....	....	....	....	.....	.85	1,216	1.33	1,520	1.9	1,824	2.6	2,128	3.4	2,432	4.3	2,736	5.31	3,040	....	.....	....	.....	....	.....
4 "	....	....	....	....	....	....	.66	1,600	1.04	2,000	1.5	2,400	2.04	2,800	2.66	3,200	3.37	3,600	4.16	4,000	....	.....	....	.....	....	.....
5 "	....	....	....	....	....	....	.48	2,480	.75	3,100	1.08	3,720	1.37	4,340	1.92	4,960	2.43	5,680	3.	6,200	....	.....	....	.....	....	.....
6 "	....	....	....	....	....	....	....	.....	.57	4,470	.82	5,364	1.12	6,258	1.47	7,152	1.86	8,046	2.3	8,940	....	.....	....	.....	....	.....
8 "	....	....	....	....	....	....	....	.....	....	.....	.56	9,540	.66	11,130	1.	12,720	1.26	14,310	1.56	15,900	1.89	17,540	2.25	19,080	....	.....
10 "	....	....	....	....	....	....	....	.....	....	.....	....	.....	.57	17,360	.75	19,840	.95	22,320	1.18	24,800	1.43	27,280	1.7	29,760	2.	32,240
12 "	....	....	....	....	....	....	....	.....	....	.....	....	.....	....	.....	.60	28,640	.76	32,220	.94	35,800	1.14	39,380	1.36	42,960	1.70	46,540
14 "	....	....	....	....	....	....	....	.....	....	.....	....	.....	....	.....	....	.....	.63	43,830	.78	48,700	.95	53,570	1.13	58,440	1.32	63,310
16 "	....	....	....	....	....	....	....	.....	....	.....	....	.....	....	.....	....	.....	.53	57,240	.66	6,600	.80	69,960	.95	76,320	1.12	82,680

and that excessive jet water at the pump may not be required.

If, added to these requisites, the automatic devices are simple in construction, self-cleaning and self-adjusting, the continuous and satisfactory operation of the circulation is further assured.

The capacity and design of automatic return valves for exhaust steam circulation have been based upon the following data and assumptions of maximum quantities with 100 square feet of radiation as a standard.

That cast iron direct radiators contain 1⅔ cubic feet of air and 1¼ feet pipe coils, 2 cubic feet of air per 100 square feet of radiation and that this amount may be increased by the contents of steam mains to 4 cubic feet.

That cast iron direct radiators weigh 7 pounds, and 1¼ inches pipe coils, 6 pounds per square foot, and will condense 16.3 pounds of steam per 100 square foot in the initial heating of the radiator from 32 degrees to 212 degrees, less the warming effect of the condensed water.

That the most efficient forms of direct radiation will condense as high as 30 pounds of steam per 100 square foot per hour for 142 degrees difference in temperature.

That the maximum amount of air entering with the exhaust steam due to that present in the feed water is .0165 cubic foot per 100 square foot of radiation. To this must be added any leakage through stuffing glands, etc., upon the steam main where the supply has dropped below atmospheric pressure. Also the air that has mixed with the steam when the circulation was first established.

The foreign matter present in the apparatus is a factor of the utmost importance and is the first consideration which governs the design of the automatic valve.

The assumption is also made that the differential pressure between the steam and the return mains is automatically controllable and can be made uniform throughout the installation.

The fixed opening in valves used in the original vacuum system was usually made between the disk and seat of the valve in order that any foreign matter carried either by the water or steam would be more readily and certainly blown out of the small passage when the disk was raised from the seat.

In the same manner the automatic valves shown are designed to draw the air and the first flow of water through a small opening between disk and seat, so that as the valve flushes with the water discharged the dirt will be carried through.

This small opening in the impulse type is the equivalent of a 3-32 inch round hole and removes the air in ten minutes with ¼ pound differential.

When the water reaches the valve, the opening if increased to ⅜ inch, its full area, would remove the initial condensation in two minutes. Tests have shown that the valve is opened to about an effective area of one-half this amount, and passes the water in four minutes.

As a 3-32 inch hole with ¼ pound differential will pass 36 pounds of water per hour, if the flow of the water was perfectly regular the impulse valve would not again open after the normal rate of condensation was established. In practical operation, the flow being regular, the valve does operate, and as its capacity at its maximum is sufficient to keep the radiator drained by being open six minutes to the hour, it may be nine-tenths of the time passing steam.

This would give a flow of one pound of steam per hour, and it would require about three and one-half square feet of heating surface upon the return to condense it.

In addition to this surface upon the return, if it is also required to cool down the thirty pounds of water to the temperature of fifteen inches of vacuum (180

Size of Main.	Sa m at Atmosphere. 100 Ft. Run. Babcock Formula. 1 oz. Drop.	Steam at 2 Pounds. 100 Ft. Run. A. R. Wolff. .04 Pounds Drop.	Steam at Atmosphere. 300 Ft. run. Webster. Square Ft. Radiation.	100 Ft. run. Drop in Pressure in Ounces. Figured from Babcock Formula.
1 "	40	36	100	6.4
1¼"	75	72	.....	.....
1½"	126	120	300	5.6
2 "	286	280	600	4 3
2½"	535	528	....	....
3 "	890	900	1,500	3.
3½"	1,360	1,320	....	... .
4 "	1,950	1,920	3,000	2.3
5 "	3,600	3,720	6,000	2.7
6 "	5,900	6,000	10,000	2.8
8 "	12,700	12,800	22,000	2.9
10 "	22,900	23,200	40,000	3.
12 "	37,000	37,000	.....	.....
14 "	55,300	54,000	....	....
16 "	78,300	76,000	....	....

degrees), six square feet of additional radiation is necessary.

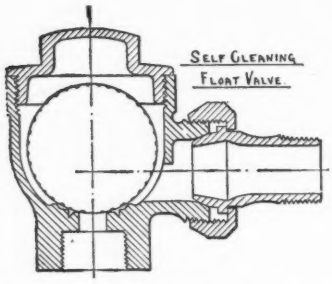
If this valve is used upon a larger radiator, additional surface is required for cooling the water and also for condensing the steam passed if the small opening is increased, but as up to 200 square feet the air would be withdrawn in twenty minutes, its capacity may be considered as equal to that amount without increase of the small opening.

If used upon a smaller radiator less radiation upon the return is required to cool the water and varying amounts up to a maximum of 10 per cent. increase for condensing the steam passed.

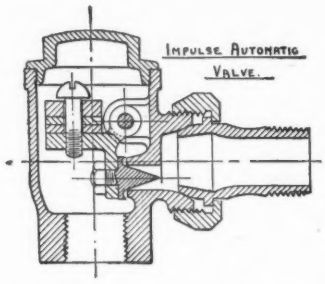
When the corrugated float type is used, the floating capacity is made sufficient to raise it against two pounds differential; the small openings may be reduced in capacity any desired amount and are self-clearing in the same way as the impulse type. The maximum capacity of this valve being the full capacity of the seat.

A water-seal may be used on all drips from mains and steam risers and connected into the controlled part of the return main; its height need not be more than 3 feet.

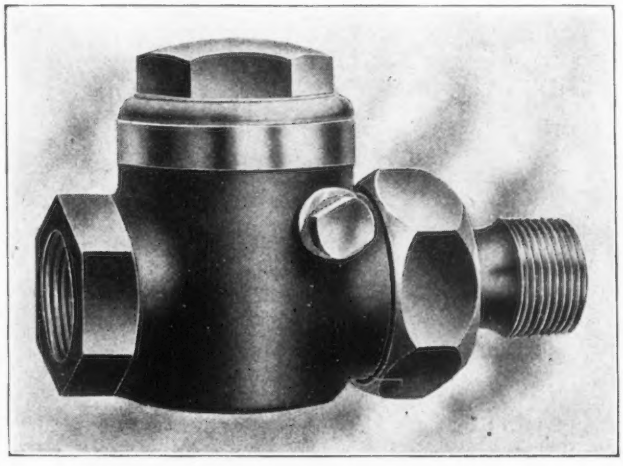
The differential controlling valve takes pressure from the steam main through a small actuating pipe upon the lower side of the diaphragm and from the branch return upon the upper side. The position of the weight (adjusted usually at ¼ to ½ pound), governs the difference in pressure between the steam and return mains upon the local part of the apparatus to which it is attached. Acting in conjunction with the automatic valve and the auxiliary radiator it meets the essential requirements before mentioned; its operation being as follows: The vacuum pump is started and the air is caused to flow faster than it can enter through the small port in the automatic impulse valve until the pressure between the two valves falls sufficiently that the higher pressure in the supply main may be able to raise the weight and partly close the passage. The flow through both valves is then of the same amount until the initial water of condensation fills the small passage through the impulse valve and acting by



RETURN VALVE FOR CONTROLLED VACUUM SYSTEM

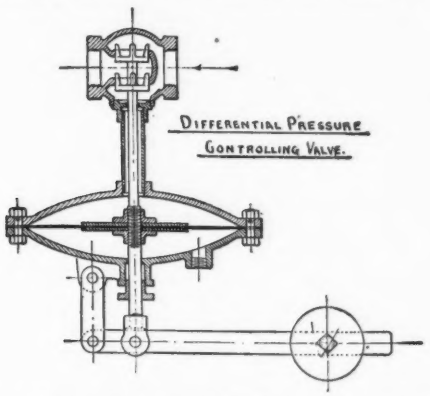


SECTIONAL VIEW OF AN ANGLE IMPULSE VALVE



AUTOMATIC VALVE—A STRAIGHT WAY IMPULSE VALVE

the force of the jet upon the impact surface it increases the opening to a large capacity. The weight (which balances the difference in pressure at which the differential pressure controlling valve is adjusted) returns the disk to its seat when

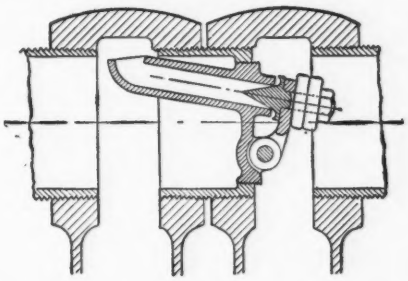


all the water is passed. Steam then flows into the auxiliary radiator through the leakage opening until a sufficient amount of the surface is heated to maintain the differential by its condensation. The differential controlling valve is then closed against the passage of air, but passes the water of condensation by acting as a steam trap. The heating plant, no matter how extensive, is thus cut up into small groups and a uniform difference in pressure is used throughout the system.

It is not necessary, although it is advisable, to use auxiliary radiation in connection with each automatic valve in order to secure good results. The controlling valve will work well with whatever form of automatic valve is used and with sufficient condensing surface to enable the controlling valve to work properly.

The Jones Decorative Glass Factory at Hudson avenue and Concord street, Brooklyn, is heated by 5-pipe, 1¼-inch coils, with one pipe upon the return outside the impulse valve.

Twenty-two inches of vacuum is carried at the pump and ½ inch through the building.

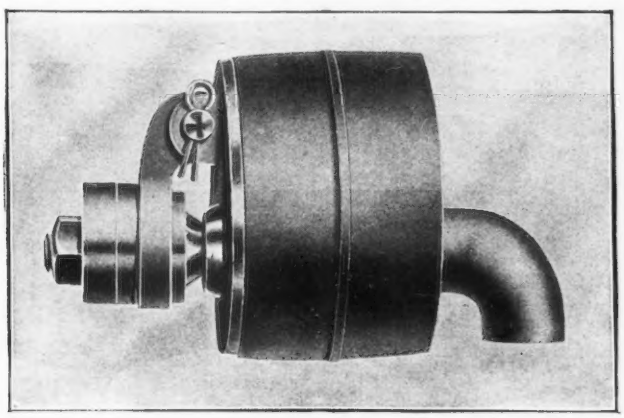


The office is heated by Standard radiators with impulse valves in the interior the radiators, leaving two sections of each upon the return.

In the same circuit as the office radiators there are some ¾-inch coils in dry kilns. One of them consists of a continuous run of 300 feet of ¾-inch pipe, yet the circulation is complete and shows no tendency to short circuit through the radiators.

The buildings of the Long Island State Hospital at Kings Park, Long Island, consist of about 44 in the Main Group, and 8 in Cottage Group No. 1.

The institution takes care of about 2,900 patients and has about 500 employees.



IMPULSE VALVE ARRANGED TO BE MADE UP BETWEEN RADIATOR SECTIONS

a simple form of float valve such as illustrated, it makes a very effective combination.

The corrugated surface of the float gives very small leakage openings so that the ordinary sizes of return pipes furnish

The coal consumption averages 15,000 to 16,000 tons per year of pea coal at $3.50 per ton. The main boiler-house has 6 Fitzgibbons boilers of 150 horse-power each for supplying steam for pumping the water supply (700,000 to 800,000 gallons

daily), electric plant, laundry, machine and carpenter shops, one small kitchen and refrigerating plant. It also has 6 horizontal tubular boilers of 100 horse-power each, for supply steam for heating in the Main Group. The auxiliary boiler-house has 6 horizontal tubular boilers of 100 horse-power each, for the heating of Group No. 1, and supplying the steam to three kitchens.

The returns from the kitchen-apparatus and from the heating go back to their respective boiler-houses with the exception of *A, B* kitchen. The steam for this comes from the auxiliary boiler-house, but the water returns to the main boiler-house.

inches of vacuum using an 8 x 14 x 16 pump upon the equivalent of 20,000 square feet of direct radiation.

The buildings *A, B, C, D*, in the main group are heated almost entirely by indirect radiation and the small buildings by direct.

The available exhaust consists of about 135 horse power in the daytime and runs as high as 270 horse power at night. There are two 10-inch steam mains from the boiler-house and one 10-inch return main. Before the heating plant was changed one of these 10-inch pipes was out of use (being laid up as a spare main), and the other carried about 60-pounds pressure

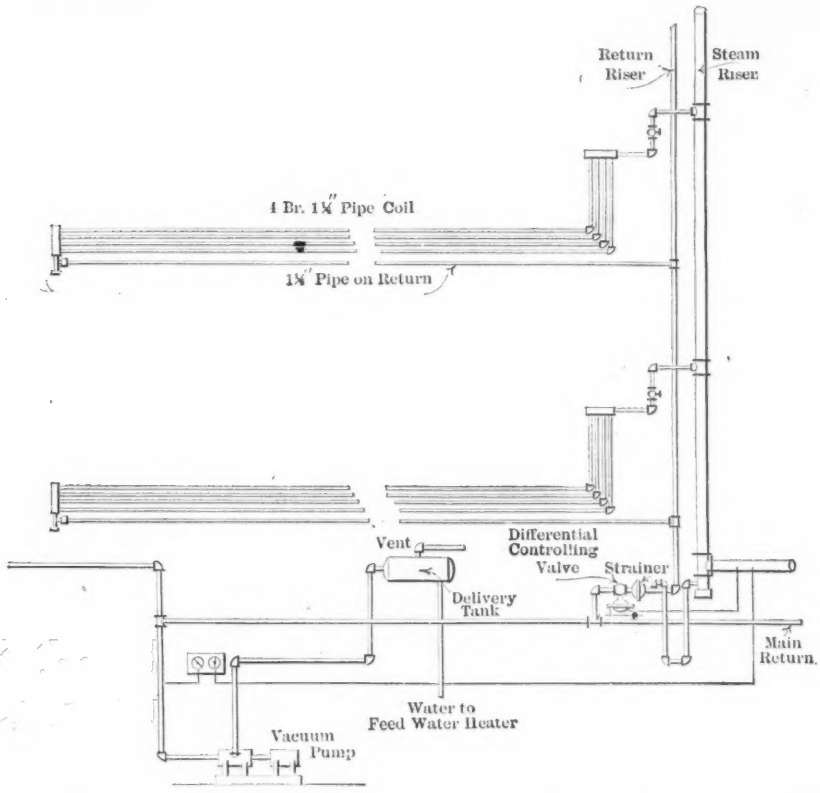


FIG. 1.—TYPICAL CONNECTIONS FOR VACUUM SYSTEM WITH CONTROLLED DIFFERENTIAL

This produces somewhat of a complication in increasing the amount of make-up water at one boiler-house and seriously reducing it at the other.

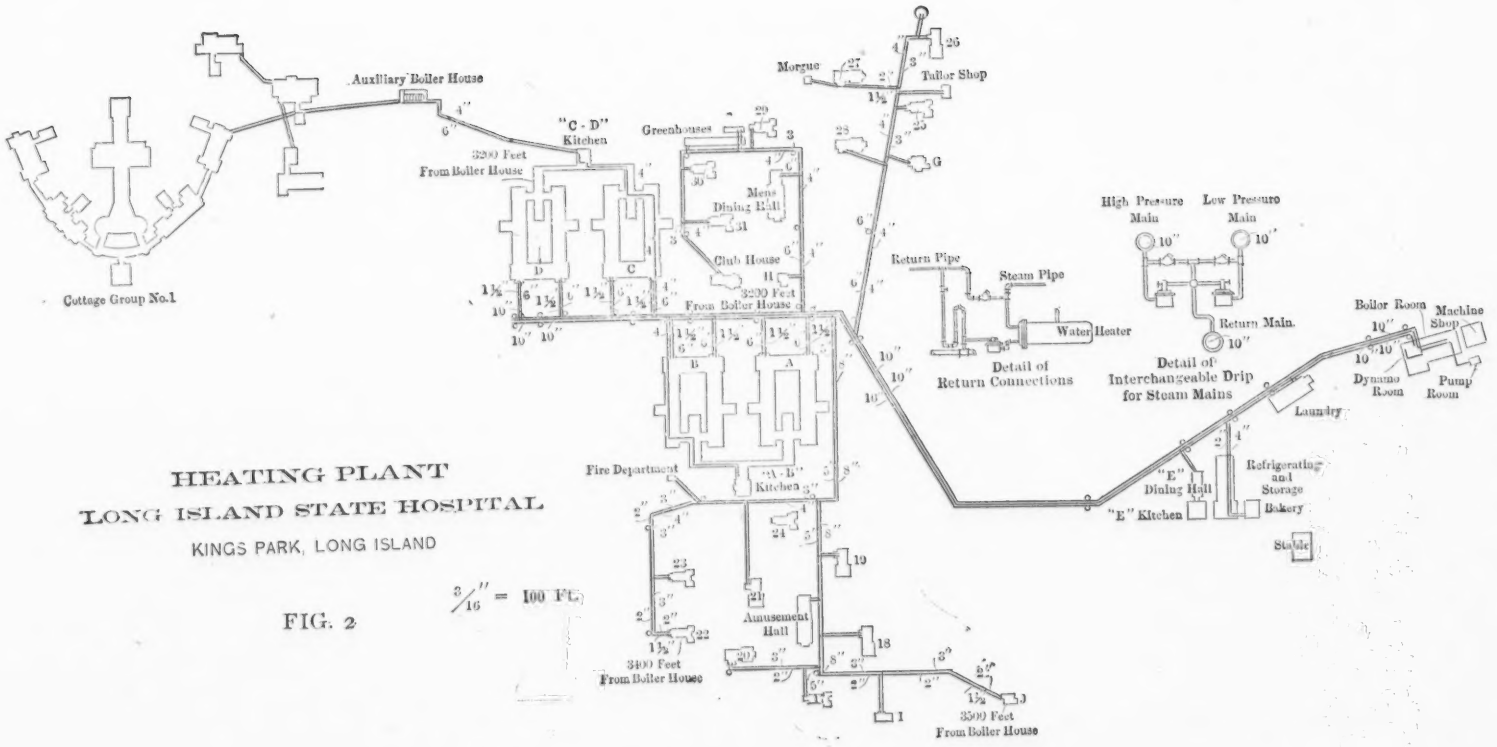
The plant at group No. 1 presents very little of interest. The buildings are mainly heated by hot blast taking steam by reducing valves from the same main which is used to drive the fan engines. The exhaust of these engines is added to the heating steam and the returns are brought back through quite large uncovered pipes.

Ten to fifteen per cent. of the entire boiler feed is probably added in cold make-up water at the vacuum pump and no difficulty is experienced in carrying 10

and supplied all the heating steam to the main group and to *A, B* and *C, D* kitchens. The auxiliary boiler-house at that time taking care of group No. 1 only.

One of the mains now carries exhaust steam and the other steam from the heating boilers at about 20-pounds pressure, which is transferred to the exhaust main through a reducing valve at the extreme end of the mains. Duplicate connections have been made so that either pipe may be used on the high pressure.

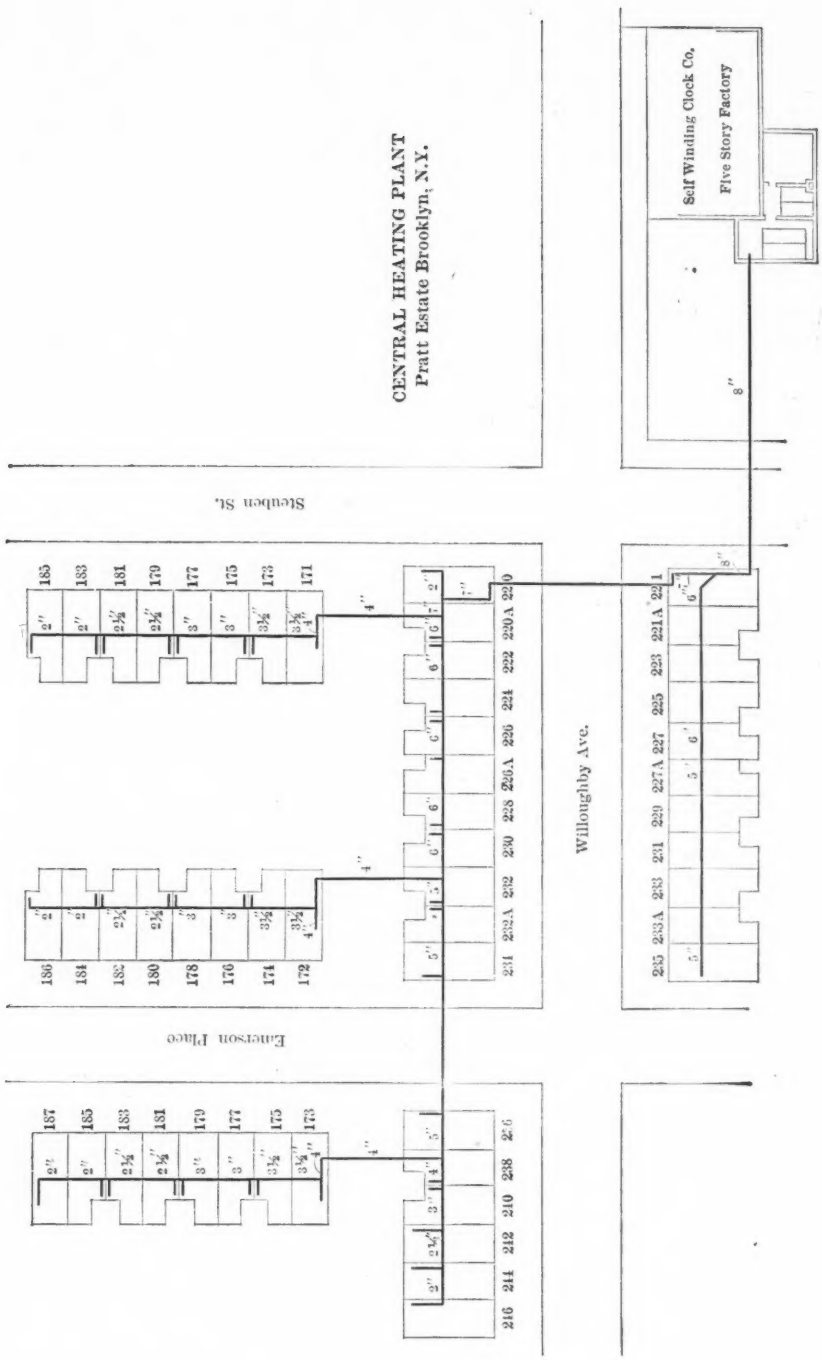
There are about 1,200 automatic pressure motor-valves used on 30,000 square feet of radiation and, as the entire return is covered as well as the jet water



HEATING PLANT
LONG ISLAND STATE HOSPITAL
KINGS PARK, LONG ISLAND

$\frac{3}{16}'' = 100$ Ft.

FIG. 2


CENTRAL HEATING PLANT
Pratt Estate Brooklyn, N.Y.
Self Winding Clock Co.
Five Story Factory
Steuben St.
Willoughby Ave.
Emerson Place
8"
4"

for make-up very limited, some unusual precautions were used to keep steam out of the main return.

The vacuum carried at the boiler-house is 7 inches and this is cut down where the return enters the several buildings so that not more than 2 inches is allowed in any. The vapor from the returns is also passed through hot-water heaters, and in some cases through radiation placed in the cold-air ducts. The method of connection to the hot-water heaters is shown. It provides for the turning on of the steam whenever the vapor from the return is insufficient. The temperature of the main return has thus been brought down so that the 10 inch x 16 inch x 16 inch vacuum pump is able to operate with a very small jet and the flow of vapor through the branch return mains is so slow that 5 inches and 6 inches of vacuum are obtainable 3,200 and 3,500 feet away from the boiler-house when there is 7 inches on the pump.

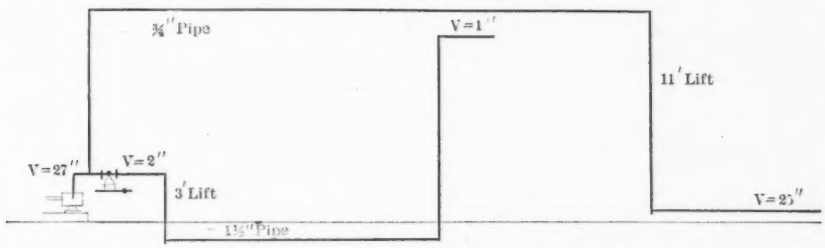
In the summer months the entire hot-water supply for this group is heated by exhaust steam and from the known saving from that source and the indications so far this winter, the yearly consumption of coal will be reduced 3,000 tons.

The eleven houses upon the north side of Willoughby avenue have a large tank for hot-water supply heated by the vapor of the return and the house, No. 221 Willoughby avenue, has its entire indirect radiation of 400 square feet heated solely by the return vapor.

When the last lot of houses was added it was found necessary to carry 22 inches of vacuum at the pump in order to maintain a differential of 2 inches at the end of the system. One pound of steam was carried at the boiler-house which gave a pressure of atmosphere at the extreme end of the line.

The 22 inches of vacuum at the pump extended into the returns of the factory when 6 inches had previously been used. A differential controlling valve was placed in this return and ½ inch of vacuum is now carried throughout the building with very good results. The thermostatic valves have the same adjustment as before, but the main return is very much cooler and 4 inches of vacuum is carried at the end of the return line.

The factory of the Kronheimer and Oldenbusch Co., 336 Butler street, Brooklyn, is a five-story building heated by 3,500



The five-story factory building of the Self-Winding Clock Co., at Grand and Willoughby avenues, Brooklyn, was originally heated by about 5,000 square feet of radiation upon the Barnard system, having gate valves with holes about ⅛ inch in diameter drilled through the gates. Water and steam were wasted in considerable quantity in keeping the returns cool until the drilled gate valves (about 25) were replaced with thermostatic valves. The apparatus then ran quite well, carrying about 6 inches of vacuum at the pump.

Two years ago two 80-horse power boilers were added to the factory plant and 38 houses were heated, and last year 14 houses were added. These houses have a total of about 13,000 square feet of radiation, 3,500 feet of it being indirect and 155 automatic pressure motor valves are used upon the drips and returns. This is a very small number of valves for the amount of surface, as the houses with direct radiators are warmed by hot water heated by the steam.

Forty-one of the houses have individual hot water supply for domestic purposes hated by the steam circulation.

square feet of coil radiation, ten per cent. of which is in two coils upon the first floor through which the returns from the upper floors pass. The condensation from the other two coils upon the first floor is lifted eleven feet and carried back to the pump upon the ceiling.

The returns and drips are provided with impulse valves and a differential controlling valve is placed in the main return pipe.

The returns which are lifted are brought back separately and connected between this valve and the pump.

Steam is circulated throughout the apparatus with the back pressure valve wide open. Twenty-seven inches of vacuum is carried at the pump and 25 inches at the bottom of the lift. The vacuum upon the main portion of the plant is cut down to 2 inches at the controlling valve, and is 1 inch upon the fifth floor. A temperature of about 210 degrees is thus maintained upon the auxiliary radiation. Without jet 15 inches of vacuum can be carried at the pump, and 13 inches at the lift.

Investigation of Accuracy of a Direct Reading Hygrometer

By R. C. Carpenter

(Presented at Eleventh Annual Meeting, New York, 1905)

The following paper is devoted principally to the description and investigation of two direct-reading hygrometers of German make, which were sold by a Chicago store for less than $2.00 each. Both instruments are apparently alike and made by pasting some organic material, probably a piece of silk ribbon, on the inside of a spring coiled in the form of a flat spiral and very similar to a watch-spring in appearance. This spring is fastened at its center to a fixed post and is connected near its free end to a light pointer. When the organic material absorbs moisture from the atmosphere it winds more closely about the center and deflects the pointer over a graduated scale in one direction, while if the air

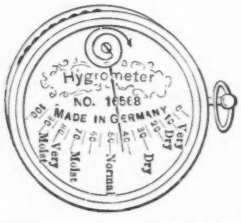


FIG. 1.—DIRECT-READING HYGROMETER

becomes dryer the moisture is evaporated from the organic substance and the spring carries the pointer in the opposite direction.

The graduations at one end of the scale correspond to full saturation, which is marked 100, and on the other end of the scale to absolutely dry which is marked 0. The form of the dial of the instrument is shown in the accompanying diagram. Fig. 1 and a perspective view in the half-tone form a photograph, Fig. 2.

The instrument is neatly mounted in a nickel case and would certainly be of great convenience to heating and ventilating engineers, provided its indications would prove accurate and uniform. Even if the instrument should not be accurate, it would prove of value if the readings remained constant for the same conditions and could be corrected by adding or subtracting a uniform amount or by multiplying or dividing by a constant number.

It is quite reasonably certain that the amount of moisture which exists in the air plays an important part in the comfort of people who are occupying heated rooms. While it is not definitely proved, it is doubtless practically true that if a room be very dry the temperature must be maintained considerably higher in order to make the occupants comfortable than if the air of the room contained a moderate amount of moisture, say 50 to 60 per cent. of that required for saturation.

Instruments for measuring the amount of moisture in the air are called either hygrometers or psychrometers. There is no particular reason for using either the one term or the other, but in order to prevent confusion between the two types of apparatus referred to in this paper the term hygrometer will be used in reference to the direct-reading instrument which has just been described, while the term psychrometer will be used when referring to the dry and wet bulb instrument which in the investigations referred to was arranged so that it could be whirled in the air. The latter was used as a standard of comparison in the tests to be described.

Direct-reading hygrometers are old inventions. I find several described in a work on Physics* which I have, which

FIG. 2.—PHOTOGRAPH OF DIRECT-READING HYGROMETER

was printed in 1771, as being at that time old. The construction as described in the old book referred to is as follows: "The moisture and dryness of the air are shown by the hygrometer which is made in several ways, but that with a cord is most common and useful; that by shrinking with moisture will turn an index one way, and extending with dryness will turn it the contrary way over the graduated limb of a circle. It would be endless to take notice of all the methods that have been attempted by philosophers and most of them without success. However, some are better than others and will endure for a considerable time very well. I shall here give an account of one which is the best of any I have hereto thought of. It is made of a string, either of hemp or catgut, and shows the increase in moisture of the air by its twisting and shortening,

* "Philosophia Britannica," by B. Martin. Third edition, Volume II, London, 1771.

and the dryness by untwisting and lengthening."

Saussure constructed a hygrometer in which he used a fine horsehair about 20 inches long, which he freed from grease by soaking in a weak solution of sodium carbonate and then washing. This is often spoken of as the hair hygrometer, one form of which is shown in Fig. 3. When the hair takes up moisture from the atmosphere it increases in length, and when it gives up moisture it shortens. This property of lengthening and shortening can be used to swing a lever or pointer over a graduated dial substantially as already described. Prof. W. Hempel, in his work on "Gas Analysis," translated by Prof. L. M. Dennis, states that such a hygrometer is very satisfactory for many purposes. It is generally constructed of the form shown in Fig. 3. A. D. Hall, in his work on "Heat," states that a better instrument may be made by using, in-

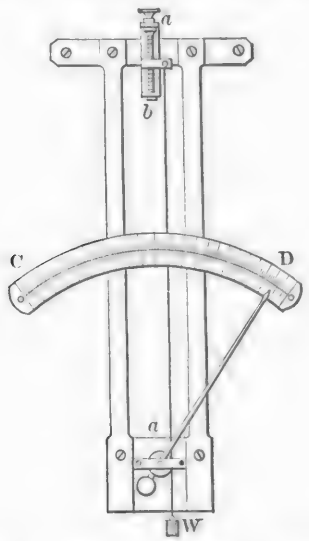


FIG. 3—THE HAIR HYGROMETER

stead of horsehair, whipcord that had been soaked in sea salt or in a solution of salt containing a little hygroscopic magnesium chloride. This causes the whipcord to absorb moisture and lengthen by untwisting when there is an increase of water vapor in the air and shorten for the reverse condition.

You are, I think, all familiar with the hygrometer sold as a toy which is actuated by the twisting or untwisting of a bit of catgut so as to bring the figure of a man to the door of a little cottage when the air is near saturation, and the figure of a woman when the air is dry. Paper flowers soaked in a solution of cobalt salt will appear red in a moist atmosphere and blue in a dry atmosphere, and may be used as hygroscopes for roughly showing the moisture contents of the air.

The instrument commonly employed by the Weather Bureau* for the determination of the amount of moisture in the air consists of a metallic frame constructed so that it can be whirled through the air and supporting two similar thermometers placed side by side and so arranged that the bulb of one is kept constantly wet, and the other dry, and both are exposed freely to the air. This instrument was

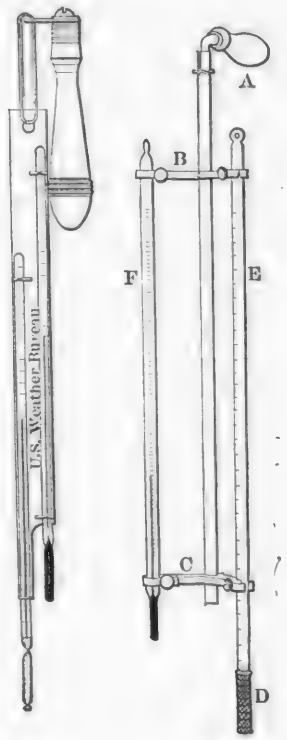


FIG. 4.—SLING PSYCHROMETER

FIG. 5.—PHOTOGRAPH OF SLING PSYCHROMETER

used at first in a stationary position, the wet bulb being kept moist by wicking which covered the bulb and extended into a cup of water beneath, the water raising by capillary action. An extended use proved the necessity of whirling the instrument rapidly in order to bring the wet bulb in intimate contact with the air which is necessary for accurate determinations. It is recommended that the wet bulb be covered with fine muslin, which is fastened with strong threads so as to fit smoothly over the bulb, and is wet by inserting the covered bulb in a cup or open-mouthed bottle which is fitted with pure, or if possible distilled, water, which should be practically at the temperature of the air. In order to obtain a reading with this instrument it is whirled

* "Psychrometric Tables," by C. F. Marvin. Weather Bulletin, No. 235, Washington, D. C., price 10 cents.

or swung rapidly through the air for fifteen or twenty seconds, with a twisting motion of the hand. It is then stopped and the wet-bulb thermometer read, the operation is then repeated three or four times or until the reading of the wet-bulb thermometer is at a minimum. This instrument, as shown in Fig. 4, is now employed as a standard by the United States Weather Bureau. The one used in our experiments is shown in Fig. 5, and differs simply in the form of the frame used. Accurate tables have been constructed from experimental data for reducing the thermometer readings so as to show percentages of saturation.* The principle on which this instrument acts is due to the fact that as long as the air is not saturated, water will evaporate at the surface of the wet bulb, heat will consequently be withdrawn from the bulb and the temperature which the wet-bulb thermometer indicates will be less than that indicated by the dry-bulb thermometer. The difference of reading of the two thermometers will be proportional to the rapidity of evaporation which is in turn a function of the relative humidity so that the dryer the air the greater is the difference between the readings of the two thermometers. No ration or theoretical law has been found connecting the readings of the wet and dry-bulb thermometers with either the dew-point or the percentage of moisture required for saturation. The results must be interpreted by reference to an experimental formula or a table which has been based upon experiments made by comparing the readings of the thermometers of the dry- and wet-bulb instrument with hygrometers of other types.

Another form of hygrometer was devised by Daniell for the measurement of the "dew-point," which is the temperature at which the air becomes saturated with moisture. Daniell's hygrometer consisted of a small and delicate thermometer enclosed in a bulb, with a broad gilt band on the outside on which it is easy to observe the deposition of dew. The bulb is connected to a second bulb and the two bulbs and the connecting tube contain only ether and ether vapor. Ether is poured on the outside of the second bulb in such a manner as to cause a rapid evaporation from one bulb to the other and a lowering in temperature of the first bulb. The temperature at which the deposition of dew takes place is the temperature of the dew-point for the given conditions. This hygrometer was greatly improved by Regnault, but although it may be made to give the dew-point accurately it is a difficult and clumsy apparatus to use and has been largely superseded by the one previously described.

The most accurate of all processes of determining the amount of water vapor in air is by passing a measured volume of air through calcium chloride or phosphorus. The air being weighed before and after the experiment, the difference in weight shows the amount of moisture which it previously contained. Hempel in his work on "Gas Analysis" describes an accurate and quick method of determining the percentage of moisture by measuring the volume before and after the water vapor has been absorbed.

The last three methods can hardly be used by heating and ventilating engineers since they require apparatus and trained observers, which can only be found in a completely equipped laboratory. The sling psychrometer is a portable instrument, but its use requires some dexterity and considerable time. The data obtained with this instrument is reduced only by consulting tables which are given in my work on "Heating and Ventilation" and by the Weather Bureau.

The object of the experiments to which reference has been made was to determine first, whether there was any direct relation between the readings of a direct-reading hygrometer of the first type and the sling psychrometer, and also to determine whether or not the errors of the direct-reading hygrometer remained essentially constant.

The experiments referred to were all made by taking simultaneous readings on the psychrometer and on the direct-reading hygrometer and comparing the results. Two direct-reading hygrometers were tested. These are referred to in the report as A and B. Hygrometer A was first tested in March, 1904; it was also tested in December of the same year. The results of the two tests are not quite in harmony, but the difference is so small that it may be accounted for by the personal errors in the readings of the psychrometers, so that it is probable that there has been no change of importance during the first year of use. The slight discrepancy noted may also be due to the fact that the psychrometer is a difficult instrument to read accurately and variations in the moisture conditions of the air in different parts of the room take place so rapidly and are frequently so serious as to cause considerable discrepancies in results obtained by different observers. I am satisfied that the results with the psychrometer depend a good deal upon the skill of the observer and the method of manipulation of the instrument.

The average of the results of the tests referred to indicate that Hygrometer A read too low by an amount which averaged very nearly two degrees, so that to correct the hygrometer reading with this instrument about two degrees should be added. Hygrometer B, on the other hand, reads high, an amount approximating five degrees. In the practical use of these di-

*See United States Weather Bulletin, No. 235, "Psychrometric Tables," price 10 cents; also "Heating and Ventilation," by R. C. Carpenter. New York: J. Wiley & Son.

rect-reading hygrometers they should be left in a horizontal position for some little time and read when in that position rather than when suspended from the ring with which the instrument is provided, being protected from moisture given off from the breath. The instruments are exceedingly sensitive to changes in moisture contents.

The general results of the investigation indicate that the direct-reading hygrometer can not be depended upon as an instrument of precision, but that it can be depended upon to give approximately the percentage of saturation when its error is known sufficiently accurate for the purposes of the heating and ventilating engineer. It is necessary, in every case, however, to find the error of the instrument, which may be done by comparing each instrument with the results obtained by use of a psychrometer of standard form, in order that the amount of error could be accurately determined and corrections made for the same when necessary.

Observer A.			Observer B.		
Range of Temperature. Deg. Fahr.	Hygrometer reads high deg. of saturation.	Hygrometer reads low deg. of saturation.	Range of Temperature. Deg. Fahr.	Hygrometer reads high deg. of saturation.	Hygrometer reads low deg. of saturation.
58 to 70	0	0 3	55 to 70	....	0.5
71 to 90	....	3.5	70 to 80	....	1.5
.....	....	....	80 to 100	....	2.5
91 to 110	....	4.0	100 to 110	....	2.3
110 to 130	3.6	....	110 to 120	1.1	....
.....	....	....	120 to 130	6.5	....

TABLE 1

made with a wide range in moisture contents for each temperature. The individual observations are somewhat variable, but the results of the comparisons obtained by three independent observers* do not vary greatly. For very high temperatures the error of Hygrometer A changes from negative to positive.

Table 1 shows the average results of the calibration for different temperatures, as made by the independent observers referred to.

The errors with an instrument of this class are not greater for the ordinary conditions of temperature and moisture content, and it will serve a very useful purpose in all living apartments, showing at a glance the approximate condition of the atmosphere of the room with respect to moisture.

The following short table is compiled from the extensive table published in U. S. Weather Bulletin 235, Washington, 1900.

RELATIVE HUMIDITY OF THE AIR

Difference of Temperature, Wet and Dry Bulb.	Temperature of the Air.		
	32° F.	70° F.	90° F.
0.5	95	98	98
1	89	95	96
2	84	90	92
3	69	88	89
4	59	81	85
5	50	77	81
6	39	72	78
7	30	68	74
8	20	64	71
9	11	59	68
10	2	55	65
12	....	48	58
14	....	40	52
16	....	33	47
18	....	25	41
20	....	19	36
22	....	12	31
24	....	6	26

TABLE 2

In the investigations to which reference was made, the experiments were conducted through a wide range of temperatures and moisture contents. This was made possible by the use of a small building which was erected a year earlier for the purpose of noting the increase in temperature with a given radiation for external weather conditions. The experiments were also

* W. M. Wilson, M.E., February, 1894; R. P. Schoenijahn, Dec., 1894; E. Hall Faile, Dec., 1894.

It is useful in reducing the readings of the wet- and dry-bulb psychrometer.

The following table is useful in computing the weight of moisture contained by the air. It gives the weights in pounds which 1,000 cubic feet of air is capable of absorbing:

MOISTURE ABSORBED BY AIR

Quantity of water which air is capable of absorbing to the point of maximum saturation in pounds per thousand cubic feet, at various temperatures:

Degrees Fahrenheit.	Pounds in thousand cubic feet.
-20	.0313
-10	.0510
- 5	.0643
0	.0806
5	.1007
10	.1247
15	.1536
20	.1887
25	.2301
30	.2797
32	.3019
35	.3380
40	.4070
45	.4877
50	.5823
52	.6246
55	.6927
57	.7414
60	.8206
62	.8774
65	.9689
67	1.0344
70	1.1400
72	1.2154
75	1.3366
77	1.4230
80	1.5619
85	1.8194
90	2.1130
95	2.4463
100	2.8237
105	3.2501

Gas as a Fuel for Hot-Air Heating

By R. S. Thompson

(Presented at Eleventh Annual Meeting, New York, 1905)

For cleanliness, convenience of management and economy of labor, gas is the ideal fuel. I believe the day is not far distant when the householder would no more think of fitting his cellar with coal in order to supply his house with heat than he would of putting a slaughter house in his cellar in order to supply his family with meat.

So obvious are the advantages of gas as fuel that on the introduction of natural gas, most people in the gas regions who had hot-air furnaces made haste to have the grates taken out and gas burners put in. They had their cellars cleaned up and their coal bins taken away.

In a large proportion of cases, after a trial for a single season, they made equal haste in having the gas burners taken out, the grates put back and their coal bins fitted up again.

So generally unsatisfactory was the result of the attempt to use natural gas in hot-air furnaces, that it became a generally accepted idea throughout the gas regions that gas was adapted only for use in stoves and was entirely unsuited to hot-air furnaces.

And yet there is no scientific reason why gas cannot be as successfully used in hot-air furnaces as in any other form of heating apparatus.

The difficulty arose from lack of proper consideration of the conditions requisite in using a new fuel. Furnace men were putting new wine into old bottles. The result was that the old bottles (furnaces) were spoiled and the new wine (natural gas) was wasted.

There is a wide difference between a gas fire and a coal fire, each developing the same number of heat units per minute.

With coal, there is a bulk of intensely heated carbon throwing off radiant heat in great quantity, consequently the fire box and combustion chamber of the furnace become intensely heated by that radiant heat and a comparatively small amount of this highly heated surface will heat a large amount of air.

There is comparatively little radiation of heat from the pure blue flame produced by the perfect combustion of natural gas. The heat produced is principally contained in the gasous products of combustion. Owing to the dilution of these products with the nitrogen from the air and with the excess air usually admitted, this temperature is not very high. One of the principal products of the combustion of gas is water in the form of steam, and this contains in latent form a large amount of heat.

In the combustion of one thousand cubic feet of natural gas there will be produced from eighty to one hundred pounds of water in the form of steam. This steam will contain from eighty to one hundred thousand B. T. U. as latent heat which cannot be utilized until the steam is condensed into water by lowering its temperature below 212 degrees.

The attempt to heat a building with steam, allowing the live steam to escape uncondensed into a chimney, would be no more extravagant or unscientific than the attempt to heat with gas while allowing the live steam produced by the combustion of the gas to escape uncondensed into the chimney.

In order to use gas successfully and economically in hot-air heating, the following points are necessary:

1. A burner which will secure combustion of all the gas which passes through it and will not permit the production of carbon monoxide, or as it is commonly called, "carbonic oxide gas."

2. A sufficient amount of surface exposed to the products of combustion on one side and to air at a temperature very considerably below 212 degrees on the other, and so arranged that the products of combustion will be reduced to a temperature below 212 degrees before leaving the furnace.

3. A sufficient quantity of air passing through the furnace to take the heat from the products of combustion without itself becoming sufficiently heated to impair its power in extracting heat.

4. Provision for getting rid of the water of condensation.

We will consider these points in order.

The Burner.—There has been much unscientific talk on this subject. The heat is in the gas, not in the burner. If a burner secures the combustion of all the gas which passes through it without the production of carbon monoxide, it has done all that can be done. Talk about burners which burn large quantities of air is all nonsense. A cubic foot of gas in complete combustion combines with a fixed quantity of oxygen. This quantity can be neither increased nor decreased. If the quantity of air supplied is insufficient, part of the gas will be unburned. If the air is supplied in excess of requirement, the excess of air will not be used. If more air is mixed with the gas than required, combustion will be imperfect and part of the gas will be unburned.

A perfect gas flame is a clear blue and perfectly transparent. A white or yellow flame, or a milky-blue flame indicates imperfect combustion. Sometimes a gas flame seems blue, but by holding an object on the other side it will be found it is not transparent. This indicates imperfect combustion.

If the flame "blows" or "lifts" away from the burner it shows too much air and consequently imperfect combustion.

If the fire "streaks up" in long, ragged flames, there is imperfect combustion.

If any portion of the burned gas mixes with the fresh gas, it poisons the latter and there is imperfect combustion, for a small amount of carbon dioxide mixed with gas renders the whole mixture incombustible.

The best gas fire is obtained by a large number of small jets so arranged that each jet will be fed with pure air and that the burned gas from one jet cannot become mixed with the fresh gas issuing from another.

A gas fire should have a supply of air in addition to that which is supplied through the mixer. It is impossible to supply enough air through the mixer to secure complete combustion, and one of the most common errors in setting gas burners is the attempt to exclude all other air.

On the other hand, if an excess of air is supplied it will unduly reduce the temperature of the products of combustion.

It is a mistake to attempt to "hold the heat back," by tightly closing the damper in the smoke pipe. When this is too tightly closed the poisonous products of combustion are retained too long in the furnace and poison the fresh gas issuing from the burner. The way to avoid loss of heat to the chimney is to take the heat out of the products of combustion and then let them escape freely. When the heat has been extracted, the sooner they are carried away the better. By actual test, with careful measurement of the heat units utilized in the air, I have found that more heat units were utilized with a free outlet to the chimney than with the damper tightly closed. In the latter case the smoke pipe was cooler, but the total number of heat units developed per thousand feet of gas was less, showing that much of the gas was unburned.

Considerable scientific knowledge, skill and common sense are required to properly adjust a burner and mixer so as to secure the proper mixture of gas and air and the proper pressure in the burner. A three-quarter inch mixer will, in some burners, carry in more air than an inch and a half mixer in others. No rule can be given. I have secured a perfect fire with a three-quarter inch mixer, using one hundred feet of gas an hour, and I have had other cases where not more than fifty feet of gas an hour could be burned with an inch and a quarter mixer. A burner adjusted for one locality may not work properly in another, as the composition of the gas and the pressure in the mains differ. The supply pipes should be of liberal dimensions, especially if long, as the friction in the pipes will reduce the pressure, and a low pressure at the mixer means an imperfect mixture of gas and air, and, in consequence, imperfect combustion.

The Surface.—It is impossible to give any hard and fast rule in regard to the amount of heating surface required, as there is much difference in the efficiency of surfaces, and so much depends on the quantity and temperature of the air carried over these surfaces. The problem is to extract the heat from the products of combustion, and no amount of surface will do this unless that surface is exposed to a constan current of air at a temperature considerably below 212 degrees. In general I have found that, with a liberal air supply, there should be about one square foot of surface for each cubic foot of gas burned per hour.

Air Supply.—This is not so difficult to estimate. Natural gas is a product of uncertain chemical composition, and this statement is even more true in regard to most artificial gas, but a good quality of natural gas should contain about one thousand B. T. U. to the cubic foot. This would heat about five hundred and fifty cubic feet of air one hundred degrees. It would therefore appear that the amount of air passed over the heated surface should be from three hundred to five hundred cubic feet for each cubic foot of gas consumed. The greater the amount of air and the lower its temperature when passing over the heated surfaces the more complete will be the exhaustion of the heat.

This raises an interesting question as to

what disposition should be made of this air after it is delivered to the room which I will consider later.

Disposing of Water of Condensation.—This is one of the most difficult problems in connection with the use of gas as fuel. A thousand cubic feet of gas weighs about thirty-seven pounds, and if of high quality contains from nine to eleven pounds of hydrogen, but as each pound of hydrogen in the gas, combines during combustion with eight pounds of oxygen from the air there is a production of nine pounds of water for each pound of hydrogen contained in the gas, and a thousand cubic feet of good gas will produce from eighty to one hundred pounds of water when burned. To allow this water to escape in the form of steam at a high temperature, involves, as already shown, a great waste of heat. To utilize this heat by cooling the products of combustion to the point where the steam will be condensed, involves the problem of disposing of the water of condensation.

By proper construction of the burner and regulation of the air supplied to the fire, a large portion of this water can be mechanicaly carried off through the chimney in the form of mist which is suspended in the air after the latent heat has been removed, but some of it will, under some conditions, form into drops, run down the inside of the chimney and drop from the furnace.

Therefore every chimney used for a gas fire should be perfectly straight and lined with tile, and provided with an opening at the bottom for the escape of the water.

In several cases I have provided for a gas furnace a special chimney made of gas pipe from three to six inches in diameter, according to the size of the furnace, with an inch and a quarter pipe at the bottom connected with a drain.

The furnace itself should be provided with some small openings to drain off the water, though, of course, the arrangement of these will depend on the construction of the furnace. I have been called to "sick furnaces" where the trouble was that the lower flues had become completely filled with water. I was called to one case where the furnace was connected with the chimney by means of a smoke pipe thirty-five feet long. This pipe near the chimney was close to a window. I found the trouble was due to a careless janitor who had left this window open and the pipe at this joint had become completely closed with ice.

Most natural gas contains sulphur, and this when burned in connection with hydrogen produces sulphuric acid. The water of condensation is, therefore, usually quite corrosive. It will eat the mortar out of chimneys, hence the necessity for lining them with tile. It will corrode iron, so the smoke pipe should be of heavy iron and coated inside and out with some acid-resisting paint. It should be kept in mind that the products of combustion of natural gas are not corrosive while hot. Corrosion begins only when these are sufficiently cooled to cause condensation of the steam. The more perfect the operation of your furnace, the more trouble you will have with condensation. Complete absence of trouble from this source is usualy an indication that the furnace is ineffective.

I referred to the problem of disposing of the large amount of air which, in using gas, is required to extract properly the heat from the products of combustion. With a furnace burning one hundred cubic feet of gas per hour this would require from thirty to fifty thousand cubic feet of air per hour. The large amount is preferable.

But a family of six persons would require for the most perfect ventilation but ten thousand eight hundred cubic feet of fresh air per hour, so if all this air that is poured into the house is allowed to escape at a temperature of 70 degrees through the windows or drawn off by a ventilating stack, there will be an enormous waste of heat.

To my mind there is but one proper solution of this problem: Return to the furnace all the air supplied in excess of the amount required for thorough ventilation.

This would require additional expense in the installation of the system. But any system of hot-air heating is defective which does not provide means for the exhaust of the waste air as well as means for the supply of warm air. A perfect system of hot-air heating should include double piping, that is to say, one set of pipes for the supply and another set of pipes for the exhaust.

Steam Heating in Connection With Condensing Engines

By Reginald Pelham Bolton

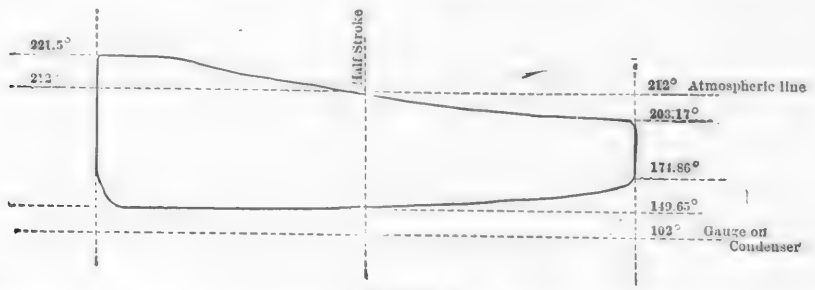
Pressures in confined spaces at less than atmospheric density are very commonly classified in a general manner as a vacuum, a term which, of course, can correctly be applied only to a condition of absolute removal of the weight of the superincumbent atmosphere.

This condition is, of course, difficult to attain by commercial apparatus and within any extended system of chambers, receptacles and piping, but the condition of less complete vacua commonly applied to condensing engines does not appear to present radical difficulty in this respect.

In the economic operation of steam engines the condensation of the exhaust of low-pressure cylinders is a necessary factor, affecting the steam consumption to a substantial extent, and reducing the pressure of the exhaust steam vapor to points considerably below the atmosphere, so that this exhaust has not been available

for use in circulation through heating apparatus designed to operate at or above atmospheric pressure.

Steam vapor of pressures below the atmosphere is, however, used and operated successfully by what is commonly described as the "vacuum" system, an arrangement in which a pressure of steam



SCALE 12

FIG. 1.—DIAGRAM OF LOW-PRESSURE CYLINDER, WORTHINGTON DUPLEX TRIPLE-EXPANSION ENGINE, MILBURN, L. I. 1904

less than that of the atmosphere is maintained in the interior of a sealed system of heating apparatus and circulated by ordinary methods.

The title above referred to is misleading. In point of fact such a system should be described as a "variable low-pressure" system, for, operated as it is without mechanical apparatus for the extraction of the contained air, the interior of the heating apparatus must first be filled with steam to such pressure above that of the atmosphere as will exclude the air contained in the system, through some form of non-return valve, after which the contained steam may be allowed to condense to a certain extent, thereby producing a fall in pressure within the apparatus to the desired point of operation, the supply being then continued so as to maintain this lower pressure. In other words, a boiler and heating apparatus, all joints and connections being maintained sufficiently air tight, is made a sealed system in which at some point of pressure, below that of the atmosphere, vapor is boiled from water, from which the air has been extracted, circulated to the radiators or coils, the condensation being returned to the boiler water level by the common methods of gravity.

With such "variable low-pressure" systems a reduced fire will provide in moderate weather a vapor at a relatively lower temperature than steam at atmospheric pressure, whereby a correspondingly less rate of heat dissipation is afforded by the radiating surfaces.

Such a system is capable of considerable variation of pressure below the atmosphere, but it does not appear to offer relief from difficulties of sluggish removal of condensation unless operated by mechanical apparatus. The introduction of additional water to the boiler, as well as any inward leakage, involves the introduction of new supplies of air to the interior of the system, which can only be removed by again raising the initial pressure to some point above the atmosphere.

The conditions under which steam at pressures below that of the atmosphere exists differ in temperature, volume and in latent heat, not only as regards the

TABLE I.

ELEMENTARY CONDITIONS OF STEAM AT AND BELOW THE PRESSURE OF THE ATMOSPHERE.

Pressures in lbs. per square inch below the atmosphere	Atmospheric pressure.	0.5	1	1.5	2	5	10	13.757
Corresponding absolute pressure in lbs.	14.7	14.2	13.17	13.2	12.7	9.7	4.7	.943
Corresponding absolute pressure in inches of mercury	29.92	28.9	27.88	26.86	25.85	19.743	9.566	1.92
"Vacuum" below atmosphere inches of mercury	.....	1.018	2.04	3.054	4.07	10.177	20.354	28
Temperature of the vapor, degrees	212	210.28	208.49	206.64	204.73	191.73	159.54	100
Heat units liberated by condensation	967.7	966.9	968.1	969.4	970.8	980	1,002.6	1,044.4
Cubic feet occupied by a lb. of vapor	26.36	27.24	28.18	29.18	30.27	39	77.69	349.7
Cubic feet occupied by a lb. of water of condensation	.01673	.01672	.0167	.01669	.01668	.01659	.01639	.01612

vapor but as regards the products of its condensation.

In further pursuing the study of this subject, therefore, it may be useful to have these conditions stated in Table I, p 17.

As an example, steam generated (at normal atmospheric pressure with a barometric pressure of 29.9 inches, or 14.9 lbs.) from water at 212 degrees Fahrenheit, constitutes for each pound weight a volume of 27 2-10 cubic feet, or 47,000 cubic inches. A pound of water at this temperature occupies a space of only 29 cubic inches, therefore the steam fills a space 1,620 times greater.

At a reduction of one-half of the barometric pressure (to say 15.29 inches of mercury, or 7½ pounds per square inch above absolute vacuum) the same pound of water occupies a relatively less space, or 28.56 cubic inches. But the steam vapor into which it is convertible at that pressure will occupy an enormously increased space of 50.8 cubic feet, or 86,745 cubic inches, a little more than 3,000 times the volume of the water.

It must further be borne in mind in order to fully comprehend the conditions of low-tension vapors discharged into enclosed spaces, that if water of saturation or condensation at a given temperature and pressure be present and be admitted to another space where a lesser temperature and pressure exists, the contained heat in that water renders it superheated for the new conditions and it will proceed to liberate this superfluous heat in the vaporization of a part of its volume.

To illustrate this, suppose a one-pound weight of heated water at 212 degrees, under atmospheric pressure of 14.7 pounds, to be admitted into a closed receptacle in which the pressure is only 7½ pounds, the corresponding temperature of which is only 180 degrees, there is then a surplus of heat to the extent of 57 heat units which will go into the formation of steam vapor. To form steam vapor at that reduced temperature requires 987.8 heat units for each pound, therefore the 57 heat units will form $\frac{57}{987.8} = .057$ of a pound weight of vapor, and as a pound of such vapor will occupy 59.6 cubic feet, the result will be 2 8-10 cubic feet of steam vapor given off by the water.

The foregoing elementary characteristics make it evident that in an entirely closed system water may be evaporated to steam vapor by a less amount of heat as the pressure is lowered. But the steam vapor so formed is of a less temperature and capable therefore of doing less work, and therefore such a method is one in which less work is done by less fuel. In other words it exhibits no economic advantage. But while this may be the case with a system in which fuel is consumed directly for the purpose of raising the temperature of a means of heat supply, it is an entirely different economic proposition if the wasted heat of a condensing engine could be made the source of heat supply and the "variable' feature of air exclusion can be dispensed with by the use of its already existing condenser and air-pump.

The subject, therefore, opens up the wide and interesting question of the use of exhaust steam from condensing engines, a matter fraught with great importance.

If it be possible to utilize for heating purposes the waste steam of a condensing engine, while still maintaining an economical degree of vacuum and thus retaining the working capacity of the cylinder, an economic result would be attained during the winter season which would advance the combined apparatus enormously in the utilization of the heat value of its fuel supply.

When it is remembered that of the heat in the fuel the actual heat value of the work done on the pistons of an engine is sometimes less than a tenth, the bulk of the remainder going off in the waste steam, or in the heat imparted to the condensed water, it is realizable how much is already accomplished by the use of exhaust steam from non-condensing engines in heating work, and how much more could be expected if the ideal condition could be attained of fully utilizing that waste steam for heating purposes after it has been used on the pistons down to pressures far below the atmospheric pressure, or, in other words, after its full economic work has been accomplished in a condensing engine.

In 1896 the Institution of Civil Engineers appointed a committee to consider and report upon the definition of a standard of thermal efficiency for steam engines.

Their report, published two years later, took the best recorded work of fire grates, economizers, boilers, engines and condensers, and plotted an idealized combination. The following diagram, Fig. 1, is reduced therefrom for the sake of simplicity to a primary basis of one million units, and shows that such an ideal combination of the boiler, with its chimney draft, grate, economizer and return feed, might be expected to deliver to the engine in the form of steam, 100,900 units out of a total of 104,200 utilized upon the grate, a little over 95 per cent. (the best approach to which in actual practice is probably not more than 85 per cent.).

Of this 100,900 units in its steam supply, the work of the ideal engine utilizes as work on its pistons only 27,360, or say 27 per cent. (in actual practice not more than 17 per cent.), part of which is due to the work of condensation, in which the balance of 79,240 units is entirely absorbed, except what is returnable as feed water, say 5,600 units, leaving a gross loss of 73,640 or 73 per cent. of the original basis, which has departed with the cooling medium or condensing water.

The utilization therefore of this large proportion, in any economic manner, is a subject affecting the total ideal economy to a much greater extent than any improvement applied to any other part of the combined apparatus.

That this proportion is not excessive may be further judged from the comparison of its final result with those of any well-authenticated tests of combined steam raising and utilizing apparatus, of which one may be here recited, having been carried out by myself upon the combined plant of the Ridgewood North Engine house, at the East New York Pumping Station, Brooklyn, for the Department of Water Supply.

The result, with internally fired boilers and triple-expansion, high-duty condensing engines, showed in the actual heat value of the work in the water delivered into the reservoir from 8.8 per cent. to 11 per cent. of the heat value of the fuel.

as the heating medium, is forcibly circulated in the heating system, passing through a primary heater around or through which the exhaust of the low-pressure cylinder passes on its way to the condenser. The heat work extracted from the waste steam is limited of course to the temperatures of the vapor emitted by the cylinders dependent upon the extent of "vacuum" carried.

In the course of a series of tests made by the writer for the Department of Water Supply, Borough of Brooklyn, last summer, at which tests Prof. Rolla C. Carpenter presided as referee, a record of the actual work obtained from such a primary heater was secured and afforded interesting results, on account of the accuracy with which measurements of the surrounding conductors were enabled to be made.

The pumping engine was a Worthington Duplex horizontal triple-expansion jack-

TABLE II.

WORK OF A PRIMARY HEATER ON EXHAUST OF A WORTHINGTON CONDENSING ENGINE, MILBURN, L. I., 1904.

	Time.	Vacuum Gauge on Condenser.	Lowest Temperature in Cylinder by Card.	Steam Passed per Minute through Heater.	Water Passed through Heater per Min.	Incoming Temperature.	Outgoing Temperature.	Increase of Temperature.
	A. M.	*In. Mer'y.*	*Deg. Fah.*	*Lbs. Weight.*	*Lbs.*	*Deg. Fah.*	*Deg. Fah.*	*Deg. Fah.*
Test at Varying Quantities	9.35	27.8	149.65	.....	17.44	66.5	118.5	52
	9.40	27.8	149.65	53.12	12.4	66.5	119.5	53
	9.45	27.8	149.65	50.12	11.59	66.5	120.5	54
	9.50	27.8	149.65	53.62	11.59	67	121	54
	9.55	27.8	149.65	53.62	11.59	67	121	54
	10.	27.9	149.65	51.62	11.59	67	121.2	54.2
	10.05	27.9	149.65	61.28	7.8	67	122	55
	10.10	27.9	149.65	54.12	4.98	68	126	58
	10.15	27.9	149.65	61.28	2.49	67.5	124	56.5
	10.20	27.9	149.65	59.28	.162	68	126	[illegible]
Aver. during 24 hrs.....	.....	27.9	149.65	54	3.44	67	115	48

It may here be observed that certain economic appliances of the nature of primary heaters on the exhaust of the L. P. Cylinders, and the use of open heaters receiving the feed water and mingling it with drops and perhaps with some live steam borrowed from the immediate receiver, also careful arrangements of steam jacketing and intermediate reheating may favorably affect such results and with them approach more closely to the ideal of the report. These elements, however, were largely present in the test referred to above.

The mention of the use of primary heaters upon the exhaust outlet of condensing engines fitly introduces here a reference to the system of hot-water heating by the use of heaters placed in such relation to the cylinders, which is known as the "Evans exhaust hot-water heating system with forced circulation." In this interesting apparatus, which has been applied to condensing engines, water, used

eted type, having reheaters fed through the jackets, and being furnished with a primary heater having 60 square feet of brass tube surface in the L. P. exhaust close up under the point of emission.

Above are the temperatures obtained on various quantities of water through the heater, with the corresponding amount of steam, the gauge readings on the condenser, which was some 20 feet away from the heater, and the corresponding degree of vacuum extending into the cylinder as ascertained by diagrams.

It will be observed that the temperature imparted to the water is higher than the corresponding temperature of the degree of vacuum carried in the cylinder and far above that in the condenser, and that this is due to the higher temperature of the point of release, which is shown in the accompanying diagram taken from one of the L. P. cylinders.

We have in the foregoing a definite measure of the possibilities of heat extrac-

tion from the exhaust of a condensing engine under a given degree of vacuum. The interesting question will remain to what extent an increase in the pressure and temperature may justify a loss in the degree of vacuum, or in other words, how far will an increase of back pressure, with its effect in reduction of the engine's work, be recouped in the work of the heating system.

Miami Light, Heat and Power Plant the following recent and interesting results kindly afforded to me:

The effect upon the engine of raising the temperature of the heating medium is illustrated by the record of some days when conditions of matter varied largely.

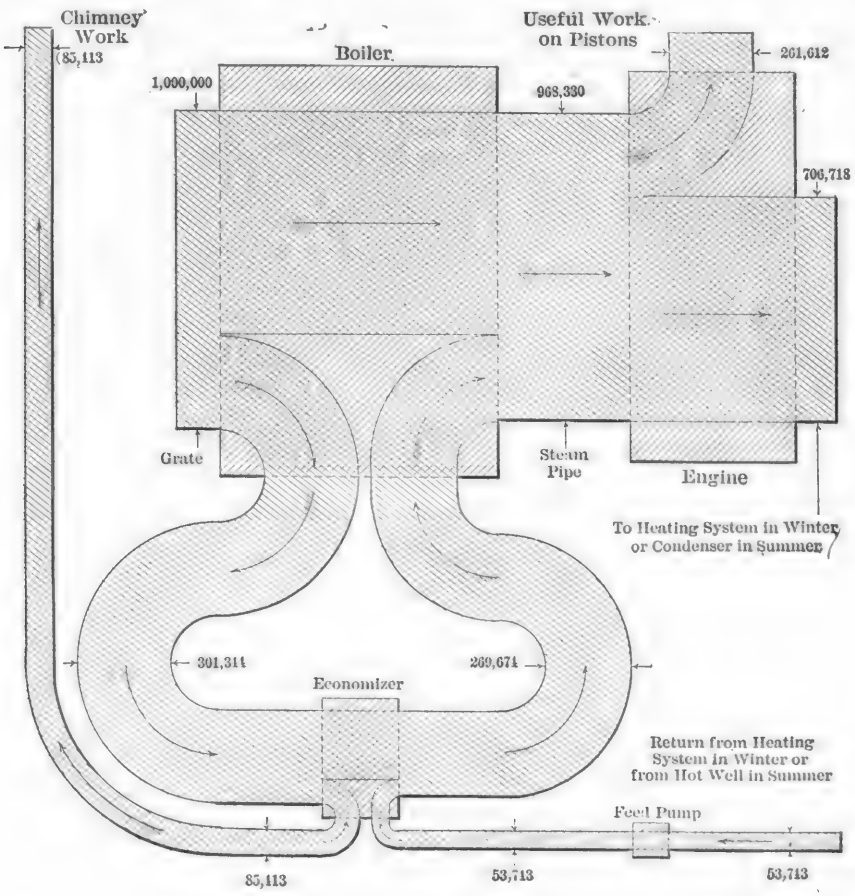


FIG. 2

The moderate temperature of the circulating water is represented as sufficing for heating purposes in moderate weather,

1904. October 12 to 22 Inclusive.		1904. October 23 to November 22 Inclusive	
Average temperature of weather...	51.7 deg. F.	Average temperature of weather...	45.33 deg. F.
Average degree of vacuum at condensers.....	21.74 in.	Average degree of vacuum at condensers.....	20.82 in.
Average temperature imparted to the heating water..... ...	132.5 deg.	Average temperature imparted to the heating water.....	143.8 deg.
Average increase of temperature imparted to the water in passing through the heater.....	3.8 deg.	Average increase of temperature imparted to the water in passing through the heater.....	4.24 deg.

This will of course vary under the many varying conditions of work and cost of fuel and will form a further interesting study for the heating engineer.

The Evans system has shown at the and, when intenser conditions of cold weather are met, an auxiliary heater is brought into play supplied with live steam for the purpose. The temperature of the returning circulating water is somewhat

raised and the primary heater then does less of the work of condensation, so that an addition must then be made to the work of the main condenser, or the degree of vacuum in the cylinder will be somewhat raised.

The results already attained show that this heated-water system possesses undoubted merit where a water apparatus is applicable, and seems to indicate a possible use of the waste steam direct for the same purpose, to which subject this paper directs attention in the hope that its development will attract the energy and ingenuity of the members of our Society and of heating engineers in general.

Such a combination is in point of fact already to be found to a certain degree in applications of the Webster system of circulation of exhaust steam, where the exhaust steam passed into a closed-heating system of apparatus, frequently circulated at a less pressure than that of the atmosphere, its products of condensation and contained air being removed by a vapor or "vacuum" pump.

In such case the heating system is acting as a partial condenser in similar manner to the primary heater, and the pump as the relief or vent to the superincumbent atmospheric pressure, in same relation as the main air-pump of a condensing system. The main condenser is absent, but in several instances the work of the pump has been desirably supplemented by an auxiliary surface-conderser or by a jet of water acting on the vapors given off by the condensed water, thereby assisting the operation of the pump, these approximating to the conditions of a condensing system.

Date.	Outside Average Temperature.	Temperature of Water.	Vacuum.
November 4.....	51.1 degrees.	131.5 degrees.	22.52 inches.
" 8.....	43.7 "	141.1 "	19.19 "
" 11.....	32.2 "	144.3 "	18.75 "
" 14.....	31.6 "	153.2 "	15.13 "

These are the elements which would appear capable of development into a method of heating by steam vapors at low temperatures, and at those pressures below the atmosphere corresponding to usual economic practice with condensing engines.

The available temperatures are so low as to be sufficient only for moderate weather, and the main question will be whether the necessary additional heat can be added to increase the temperature of the vapor when required. If it can, this source of heat supply, now generally wasted, may be largely utilized for heating purposes. Under what conditions this may be arranged, either as a "by-pass" or "shunt" from the line of travel of the steam vapor from the cylinder to the condenser, or by a direct passage of the whole volume through the heating system towards the condenser, will be a matter of study and experiment.

The second suggested method would appear to offer the best opportunity of solution.

The question of additional heat to be added to such a system would offer more difficulty than in the case of heated water, since the introduction into the system of a volume of live steam would tend to set up a back pressure more directly than by the raising of the temperature of circulating water.

But the supply might be so arranged as to be directed into the radiating surface where its work would be done directly upon the covering surface and its heat, or the steam-vapor may itself be superheated by the application of steam taken from the intermediate receiver or by live steam or heat of waste gases.

Such superheated steam need not then imply an increase in back pressure, if the superheated supply be actively drawn through the heating system by the action of the main condenser as proposed above.

Experience With Radiators in the Top Story of a Building

By A. B. Reck, Copenhagen, Denmark

In discussing methods of computing radiator surfaces in proportion to heat-absorbing surfaces (windows, walls, ceilings, etc.), with American engineers, I have in some instances found that they employ rules which I think will give them too small radiators in the top story of a building, the rules not taking sufficiently into account the loss through the ceilings for that story. For this reason I have thought that it might be useful to mention that I have had to to do with a case this winter where it has been necessary to increase the radiators in all the rooms of the top story in a building, although some allowance for the ceilings really had been made in the size of the radiators, only the allowance not being large enough, because I had understood there was an attic (unheated) over the story, whereas in reality there was not, the protection against loss of heat being only a ceiling of lath and plastering, an air space and the ordinary sheathing, roofing-felt and gravel on the roof timbers. The building of which I speak is one of the buildings in Chicago in which has been in-

stalled the Reck Hot-Water-Circulator system described in the paper I read before this society at its meeting, January, 1904. In the building in question the radiators are distributed in 80 rooms on three floors and have a heat-emitting capacity of about 5,000 nominal square feet of hot-water heating surface. (Those of you who recollect my paper from last year will perhaps remember that what I call a "nominal" square foot is a square foot emitting 160 B. T. units an hour.)

The calculation of the radiators was based on 80 degrees difference between outside and inside, and for rooms with equal areas of walls and windows the radiators in the top story were given one nominal square foot more than the radiators on the floor below for every 18 square feet of exposed ceiling. This augmentation of the radiators on the top floor was based on a rule employed by me for rooms with unheated attics over and the rule gave radiators on the top floor in many instances 33 per cent. larger than the radiator on the second floor in rooms with same areas of windows and walls.

Notwithstanding this the radiators on the top floor very soon proved to be insufficient to produce the same temperature as the radiators on the second floor, and the right temperature on the top floor was only attained by giving the radiators here one "nominal" square foot of area more than the radiators on the second floor for every 9 square feet of exposed ceiling, this being my rule for ceilings with no attics over, such as described in the beginning of my paper.

In the building referred to the radiators in many rooms on the top floor have now 66 per cent. more heating capacity than the radiators in rooms on the second floor with equal window and wall areas, without being larger than necessary. Seeing this I have thought it useful to direct your attention to this point that no rule for proportioning radiating surfaces will hold good for top floors unless some increase is given to the radiators here taking the areas and the construction of the exposed ceilings in consideration.

The Circulation of Hot Water

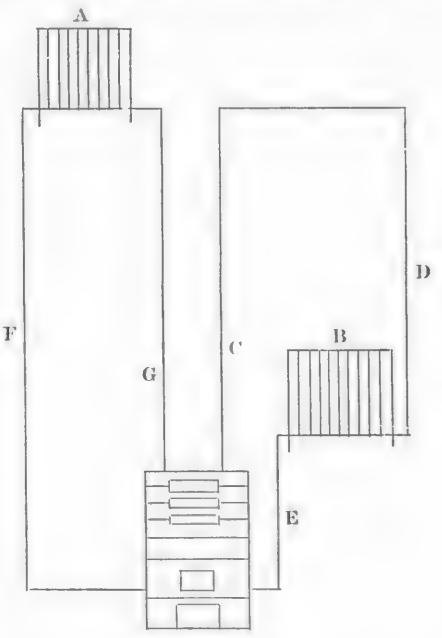
By John S. Brennan

(Presented at Eleventh Annual Meeting, New York, 1905.)

The first cause of the circulation of water in a hot-water heating system, by the force of gravity, is that the water becomes denser as it cools off, and it therefore outweighs the warmer and lighter water and pushes it to the top of the apparatus. Hot water will move when there is a heavier and cooler body of water to displace it and force it upwards by means of its superior weight.

The force which propels the water in the risers and radiators is proportional to the difference in the mean temperature of the ascending and descending parts of the apparatus, and is also proportional to the vertical height of the circuit. For example—in a circuit or riser 50 feet high the motive force would be twice as large as one only 25 feet high.

The force of the circulation through radiators with a given fall of temperature depends mostly upon the height of the return pipe and is independent of the height of the riser pipe above the radiator. Take, for example, a radiator on the fourth floor, A, or 50 feet high, another radiator on the first floor, B, or 10 feet high, with both feed or riser



pipes the same height. The circulation through the radiator on the fourth floor will be about three times as great as through the radiator on the first floor. Notwithstanding the fact that the supply column of both radiators are of equal height because the return, F, is about three times as high as the return, E, of the radiators on the first floor. The temperature of the pipes C and D are nearly the same, consequently the water in D simply balances an equal height of pipe C, and fails to supply any force for circulation. The force for circulation in this circuit therefore depends upon the preponderance of the weight of water in the return pipe, E, over the weight of that in the pipe C below the level of the radiator B.

Fig. 1 is a fair illustration of a radiator with the usual style connections. The force of the circulation through the radiator depends upon the height of the return column. The return pipe having a strong pull on the radiator the more di-

rect parts of the current are along the lines indicated by the arrows and the water up in the radiator has circulation. shows the actual current within the radiator. The hot water must pass directly to the top, dropping to the bottom, as it

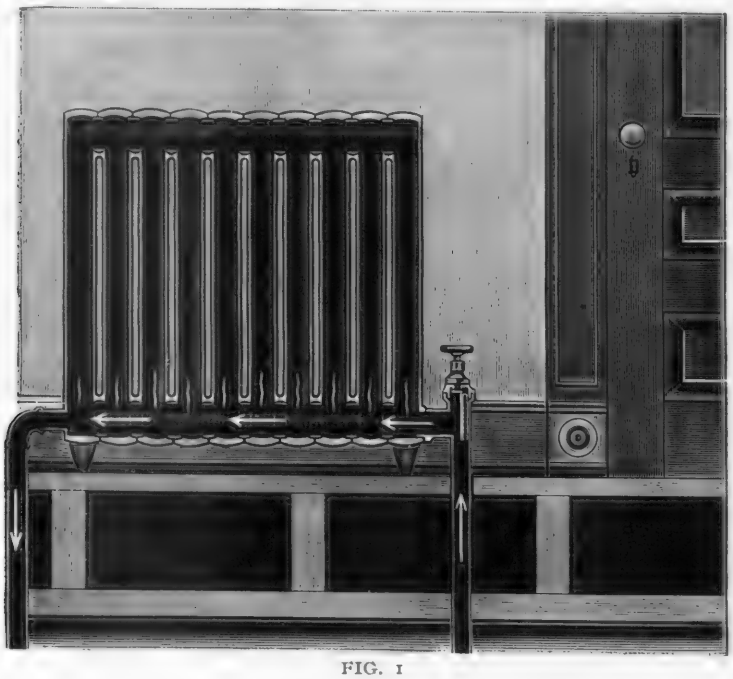


FIG. 1

Fig. 2 shows an improved connection to increase and improve the circulation in a hot-water heating system, which has cools off returning to the return pipe. The circulation is positive and by actual tests the entering water is 6 degrees hotter

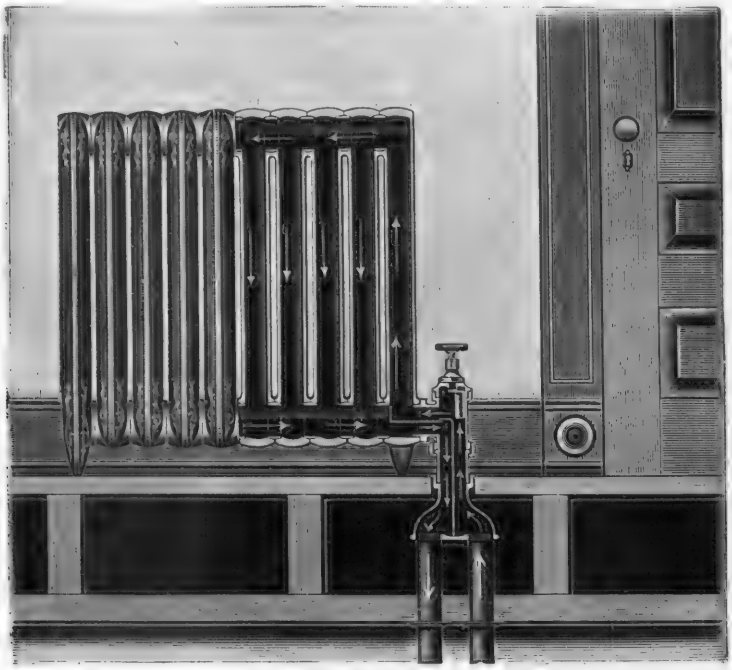


FIG. 2

been successfully used by the writer on a great many hot-water heating systems. The direction in which the arrows point than the circulation the old way, and, furthermore, the entire surface of the radiator is heated. I have compiled figures

of tests of these two styles of connections for radiators. A thermometer was placed on the feed and return section of each radiator, the connections on the usual style of radiator shown in columns 4 and 5 were 1½-inch inside diameter on the feed pipe, and 1½-inch pipe on return pipe, the connections on the improved connection shown in columns 2 and 3 were 1½-inch connection with a partition in it with 1½-inch feed and return pipe.

Column 1 is the time in which the test was made. Column 2 is the top return section of the radiator with the improved connection, and column 3 is the thermometer on the feed section of the radiator with the improved connection. Column 4 is the thermometer on the return section of the radiator with the old style connection. Column 5 is the thermometer on the feed section of the old style radiator connection. The radiator in columns 4 and 5, or old style connection, is a 13-loop 38-inch high Corinth radiator, containing 71½ sq. ft. radiating surface. Columns 2 and 3, or the new style connection, is a 24-loop 14-inch high Unique radiator containing 96 sq. ft. of radiating surface. It will be noticed that the thermometer on column 3 or feed pipe of improved connection is higher than the one on column 5 or feed pipe of old style connection, it being six degrees higher and remaining somewhat higher until the thermometer registers 212 degrees.

1 Time.	2 Return Therm.	3 Feed Therm.	4 Return Therm.	5 Feed Therm.
3:55	88	213	210	213
2:05	88	98	88	92
2:10	98	108	97	102
2:15	108	116	106	110
2:20	122	128	120	122
2:25	126	132	124	128
2:30	132	140	132	135
2:35	140	146	140	142
2:40	144	152	144	146
2:45	150	158	151	152
2:50	156	161	156	158
2:55	158	166	160	163
3:00	160	172	163	170
3:05	166	178	173	165
3:10	172	182	177	180
3:15	176	186	182	184
3:20	180	190	186	188
3:25	184	194	190	192
3:30	189	199	196	198
3:35	192	202	198	202
3:40	196	206	202	206
3:45	200	210	206	209
3:50	206	212	208	212

The principal object to be sought in designing a system of hot-water piping is to adjust and equalize the resistance in each circuit and branch so that the hot water will flow with equal readiness to each radiator. This is accomplished by making the diameter of each pipe just sufficient to pass the desired amount of water under the head or drawing force which is available in that particular part of the system.

Heretofore a great many people objected to hot water as a means of heating by reason of the radiators having a connection at each end, and when any cleaning or painting was done behind the radiator it was necessary to drain the water from the radiator and disconnect it from the flow and return pipes. This necessitated shutting down the apparatus until the radiators were connected again.

The trouble and annoyance incident to setting and connecting a radiator with two pipes in or above the floor in the usual way are avoided by this improved connection which requires but a single opening to be cut in the floor and a single coupling to be made above the floor. This improved connection by its peculiar construction allows a radiator to be swung away from the wall without interrupting the circulation of the water. This is very useful when using the apparatus when the building is being erected. The heating apparatus can be installed complete and the radiators swung out, and when the building is completed they can easily be swung back in place again.

The Outlook for 1905

To set forth a long series of reasons why a good business may be expected this year would be the orthodox way in which to write a forecast. But the conditions at this time are of such a character as to cause the presentment of this subject to be arranged in reverse fashion. To put it interrogatively, why is not a good year to be expected? Are there any clouds on the horizon? Is any kind or manner of business suffering from more than temporary or seasonable inactivity? Is any considerable number of people unemployed who desire to work? Has the purchasing power of the great mass of consumers been diminished to any extent by the developments of the past year in agriculture, mining or other of our productive industries? Is there at present any prospect whatever of curtailment in the demand for manufactured products? Answers to these questions are so uniformly favorable that he who would prefer to see business drooping and values declining must look further afield than can mere ordinary mortals. It may

be possible that in the recrudescence of prosperity now being enjoyed by this country the seeds are being sown of a crop of adversity which must at some time be harvested. This is a law of nature, physical and economical, but so far as human foresight can take in the prospect which now stretches before us the year upon which we are entering appears exceptionally promising.

If we were celebrating a long period of great activity, with its inevitable accompaniment of expansion in productive capacity and indiscriminating haste to take advantage of fast flying opportunities, it might be well for us to speak cautionsly, act warily and hold ourselves in momentary readiness to hedge against a shrinkage in the demand and falling markets. But it is barely three months since we emerged from a state of business rest and almost of stagnation which had continued for over a year. During that time ultra conservatism ruled. Consumption was certainly much under what it should have been to take care of natural waste and provide for reasonable growth. It is unnecessary to expatiate upon the causes which brought about the decline in trade. They have been exhaustively treated in these columns in the past, and it is enough to say that they are no longer operative. But now that the depression is ended we can derive some satisfaction from it through the realization that the economy in buying which then actuated consumers has turned itself into a present blessing of sustained orders, which in some instances have been of unprecedented volume.

Rarely has the iron trade of this country entered the winter with such pronounced activity in all departments as in the case of the current season. When the awakening demand first made itself felt in pig iron in September wise heads were shaking ominously, as it was considered quite out of the question that any great volume of business should develop in the autumn. As time wore on, and the activity seemed to confine itself to pig iron, the comparatively light trade in finished products became a matter of critical comment, and those who had misgivings about the strength of an autumn demand began to feel sure of their position. It is safe to say that everybody in the iron trade was taken by surprise when the buying movement was perceived to be spreading to finished products. So rapidly did the change occur that manufacturers were largely unprepared for it. Prices which had been with difficulty barely sustained by trade agreements were suddenly forced above the official schedules by the pressure for more rapid deliveries from eager buyers. As usual, advances in price stimulated trade instead of repelling it, and the close of the year found blast furnaces, rolling mills and steel works which had long been idle either actively at work or making vigorous preparations to resume operations. As an index to the condition of trade in finished steel products the status of unfilled orders on hand by the United States Steel Corporation may be cited. It has the equivalent of more than six months of its maximum output now under contract, with the rail trade heard from to but a limited extent. It may be assumed that the outside interests have fared equally well with the United States Steel Corporation. Thus for at least half of 1905 steady running seems assured for the finishing end of the iron trade. As to pig iron, the present rate of consumption leads to the belief that, unless prevented by inability to secure a sufficient supply of coke and ore, the production for the first six months of this year will exceed considerably the output in any previous half year.

This promising outlook has been gained with what may be considered as only the beginning of the demand for iron and steel from the railroads. They have been fairly liberal buyers of steel cars and locomotives within the past three months, but their orders will have to be very much larger to come up to the average of the five years 1899-1903, which should now represent approximately their normal requirements. Their purchases of rails and bridges for delivery this year have been quite light thus far. It is known that they expect to purchase quite heavily of these necessities for permanent way, as they stinted themselves in both 1903 and 1904. This year they will be more able to indulge in expenditures for renewals and improvements, as earnings for several months have shown a gratifying increase over the corresponding period of the previous year. Those who deem it desirable or find it necessary to raise funds through the issue of securities can do so with greater facility than for years, as money was never more abundant than now, and only in times of great depression have interest rates been so low. This ease in the money market should also prove advantageous to enterprises of all kinds, either new or held in abeyance by the depression of 1903-1904. As far as can now be seen the volume of business promises to be greater rather than less as time unfolds the scroll of 1905.—*The Iron Age.*

The smallest building of modern construction in New York is now being erected in Broadway, between Sixty-third and Sixty-fourth streets. It has a front on Broadway of 20 feet and is triangular in shape, the base of the triangle being only 15 feet. The material is steel, stone and brick, and it is to be only one and a half stories with a cellar. The small trangular lot is the result of the irregular course of the old Boulevard at that point. The building will be used for an office.

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IN our December number we referred to the fact that a feature of the January meeting of the American Society of Heating and Ventilating Engineers would be the presentation of the first report ever made by the committee on compulsory ventilation legislation.

The reason for the absence of a previous report has been the lack of anything tangible to report. Work has been done, all kinds of efforts have been made, committees of one and committees of three have gone to state capitals and, forearmed as well as possible with letters from people of influence, have done everything they could to bring about the result which was accomplished last year. While those who have taken an active part in bringing about this result have been comparatively few, they have represented the sentiments of the Society and have acted upon formal resolutions of the Society. What has been done, therefore, may be considered as the work of the American Society, and it is a work the effects of which are so far reaching that it is difficult to see where it will end. We can only predict a marked benefit to school children and all other residents of the state; also, in the future, we may hope, to the residents of all other cities.

BUSINESS conditions in the heat- and ventilating line were never more promising than at the opening of 1905. The trade which continued in such a depressingly small volume through the first half and well into the third quarter of 1904 came on in a deluge and seems to be still coming. Present indications are that those manufacturers who provide themselves with an adequate supply of goods and take the right course in getting before the trade will have the best year in all history.

ANOTHER most important factor is the item of price. With costs high, and tending to advance, and with a demand promising to consume everybody's product, there is every reason for manufacturers to strengthen their selling prices.

That has been recognized by that influential section of the boiler and radiator manufacturing business known as the Carbon Club, who have raised their prices some seven per cent. There is a strong reason for all the other manufacturers of such goods to take similar action and to aim at about the same advance.

This being done, it is most important that all parties should stand firm and let a reasonably uniform price prevail through the year. That would be beneficial, not only to the manufacturers, but to the contracting trade to whom stability in prices is of exceedingly great value.

THE Lawson of the building trades has arrived. A New York building contractor has attacked "the system" in true Lawsonese style, setting forth in the columns of

the daily papers that there is a conspiracy existing between the building trades employers and their employees and that in consequence of this conspiracy the cost of building is so unreasonably increased that owners do not dare to undertake any building operations.

What has happened during the past two years has been the bitterest kind of industrial warfare between the employers and a clique of walking delegates who rule, to some extent, the employees. Of late there has been a slight relaxation of hostilities, partly due to the fact that two blackmailers were convicted and sent to prison and partly, no doubt, due to the other fact that a large majority of the workmen are "sane and safe" and want to work a decent number of hours and do decent work during those hours, and to get decent pay.

THE "frenzied builder" tells some stories which are interesting if true. He tells about a man who wanted a $1,300 conservatory and paid $83,000 for it. Possibly a few such men have lived and will continue to live, but mostly they have died young.

Many people, having set aside a certain sum of money for the erection of a certain building, find that they have guessed so badly that the cost of what they want is greatly in excess of their early imaginings. Many others lack foresight to the extent that, after a thing is completed in accordance with original specifications, they do not like it and want the work all torn out and done over again in another way. If, therefore, a man starts with a $1,300 conservatory and concludes that he wants something different, and has it pulled out and a $3,500 conservatory erected in its place, he has to pay presumably more than $1,300 and $3,500, because it costs something to tear out old work.

EVERY contractor knows the nuisance of tearing things out and replacing them. He knows that he cannot possibly make it appear to a critical and narrow-minded eye that he has actually expended the time and labor that he really has had to pay for and that he must, in justice to himself, charge for.

We alluded a few months ago to a case of that kind, where a house was wrecked by the freezing up of the heating and plumbing systems and the consequent explosion of an unwisely fired boiler, and the contractor who was asked to make figures on it declined to have anything to do with it. Presumably some other contractor did the work of repairing and undoubtedly he lost money and was also set down as a thief and a robber; but $83,000 for a $3,500 conservatory is pretty extreme.

THE Building Trades Employers' Association of New York is composed of a number of men and firms who like to make money, but they are also a class of men who do not aim at making a thousand dollars in one day, to find themselves without anything to do for the rest of the year. They would rather be profitably occupied about three hundred days in the year. Moreover, they are not as a class congenital idiots, and are not in the least likely to kill the goose that lays the golden egg. They want to see all possible building done. They figure pretty closely, to get their share of the contracts, but they do like to feel that they are going to come out with a balance on the right side of their cost sheet.

Now, everybody who is not a frenzied financier or a frenzied builder knows that it has been common talk in several of the large cities of this country for a good many months that it was not at all safe for a man to take a contract to execute a certain piece of work within a specified time excepting at a price somewhat out of proportion to the real, proper cost of the work.

In the first place, there has been more or less fluctuation in prices of material. That, however, is something that can always be guarded against by placing orders for material the day the contract is awarded. The most conservative do that—and more, they protect estimates in many cases, before the contract is awarded.

WHAT has been more important is the hold-ups of the labor unions. There was a time, not so long ago, when a contractor could not be certain of going to his office for the day without finding that some union or another had decided that they would only work a part of the day, or else that they would only work full time for a great deal more money, or perhaps they were in sympathy with a bunch of laundrymen out West and would not work at all.

He would still have had a little chance if he could have gone into the market and bought other labor, but the famous "entertainment committee" used to come around with sandbags and big sticks and make it uncomfortable for outside labor to mix up with the game. Consequently no contractor, unless he was a born gambler, felt like taking a contract at anything like a proper price.

That state of affairs brought about the condition indicated by this builder, but it did not at all arise from the cause which he specified, and that condition does not exist to-day in anything like the same degree as a year ago. The change is not due to any conspiracy between the employers and employees, but to an approximation of the open shop, and consequent fair competition all around.

IN all lines of business the primary tendency is in the direction of competition so keen at times as to be destructive of profits, and consequently ruinous to the competitors.

Following this comes a tendency to work in some sort of harmony and good understanding between competitors, with the full knowledge that any successful attempt to over-reach and to rob the public will be a direct invitation to new competition to engage in that particular line of industry.

While, therefore, in some financial lines special advantages may be, and doubtless have been, followed up to the reaping of an undue profit, it is not on record that many heating and ventilating contractors have accumulated millions by suppressing competition and extorting sinful prices from the public. The drift is rather in the other direction, for there have been multitudes of cases where contractors failed for no other reason than the giving away to their customers of what should rightfully have been their own profit.

This is not due to philanthropy on the part of the contractor, but to inability to figure correctly, or an undue desire to secure business, leading to the taking of unsafe chances. But the fact remains that in this particular branch of industry the average profits are not commensurate with the capital involved and the ability and industry demanded.

NOW it is proposed to organize a Builders' Association to be composed entirely of men or firms or companies who will take the contract for the entire construction of a building.

So far as this subject affects the lines in which we are interested it is unnecessary to remind our readers that the general contractor in different cities has constituted the most effective drawback to good heating and ventilating work—unless possibly we except the speculative builder, and it is probable that the speculative builders will be found in the ranks of the new builders' association if such an association is organized.

We have all of us known instances where the heating engineer and contractor has been anxious to install a thoroughly high grade system and where the owner wanted such a system and had had the money to pay for it. Instead of the heating contract being awarded to the best bidder, the one giving the strongest assurances of the best job, having, of course, due regard for the price, cost has been the controlling element and the lowest bidder installed the cheapest job.

This is entirely natural when the general contractor is paid a limited sum for the completed building and every $5.00 bill added to the cost of any part of the work comes out of his individual pocket, without yielding him any corresponding return excepting that he had to use special judgment to see that he got a job that would answer a sort of a purpose—at all events one that could not be made the basis of a successful claim for completion, or even damages, through the medium of the courts of law.

AT the same time, there is such a great deal of human nature in the world, and it is not to be wondered at if some of it should be found in the membership of employers' associations. We have previously had occasion to point out instances where employers having an apparently strong organization have shown a disposition to use their power in an injudicious way. Probably that sort of thing will always prevail, in politics and in business and in religion. We are not prepared to assert that if the employers could have everything their way they might not be at times a little niggardly in the matter of wages, and perhaps sometimes a little extortionate in the matter of their charges.

LET us not be misunderstood as showing a tendency to treat this part of the subject lightly. We have known of too many cases, particularly in moderate sized towns, where the organization of employers in some particular trade controlled the situation so thoroughly that they were able to make about any price they saw fit. And we have known of instances where organizations having such power used it very badly—to the detriment of the public and of the workman, and to the ultimate detriment of their own business.

BUT we are discussing simply the present situation, and to say that the troubles which have afflicted the building industries of New York and Chicago and various other cities for the last many months are not primarily due to the wrongful demands and the baneful operations of labor unions would be to state something that is contrary to general knowledge.

I heard of a funny accident that resulted well. A prominent and estimable firm of heating contractors had occasion to figure on the heating of a large building and when the bids were opened they found themselves so low that they went over the specifications again with a very scrutinizing eye. When they found that they had made a mistake of $30,000 in their bid, they suffered all of the known varieties of heart disease and nervous prostration.

It happened, however, that the combined estimates on the construction of the entire building exceeded the appropriation, so that all bids were rejected. When the job was finally let, I do not know what this firm figured; I imagine that they tried to get $30,000 high. At all events, I know they lost the contract and are not worrying about it.

That reminds me of a case a few years ago where a concern that was trying to "butt in" for large work in this town took a contract at a pretty low figure, and pretty soon thereafter occurred the extraordinary advance of some five years ago in the cost of labor and of every kind of material that goes into a heating job. This, on top of an unduly low bid, cut short the career of those enterprising contractors.

It was a public job and they had to give a bond, which they went and bought from one of the regular indemnity companies, and when that indemnity company found it was their turn to go out and buy material and hire somebody to complete the work, they experienced some unhappy moments. I believe they have not been happy since, because they had to stand a good net loss of some $60,000.

All these seem big figures in comparison with the first case of this kind I ever saw. I had a friend out West come to me with tears in his eyes, saying that he had got a contract and, on reviewing his estimate, found that he had made a mistake in addition of $1,000. That struck me as a pretty big proposition, although he could perfectly well afford to lose a thousand dollars. He showed me his original figuring sheet and I told him to take it to the architect and tell him the story just as he had told me. I also reasoned with the architect. The result was that the contractor got $500 or $600, simply as a piece of decency on the part of the architect and owner.

It is the almost universal comment of steamfitters that manufacturers of boilers and radiators have distinguished themselves this fall and made a new record for getting out goods to meet the unexpected and wholly unprecedented demand.

To be sure, they were slightly favored by the absence of any severely cold weather until pretty far into November, but the strain was great and, for the first time in the history of the business, everyone connected with most of the manufacturing companies welcomed the relief when the pressure began to slacken.

The New York State Law for Compulsory Ventilation

At the request of many of our readers, both within and without the limits of the State of New York, we print herewith the text of the law enacted at the last year's session of the New York State Legislature, relating particularly, so far as we are concerned, to the ventilation of school houses and public buildings within the limits of the State of New York.

This constitutes part of the report of a committee to the annual meeting of the American Society of Heating and Ventilating Engineers this month.

STATE OF NEW YORK

An Act to amend the consolidated school law, relative to proper sanitation, ventilation and protection from fire of school houses.

No school house shall hereafter be erected in any city of the third class or in any incorporated village or school district of this state, and no addition to a school building in any such place shall hereafter be erected, the cost of which shall exceed five hundred dollars, until the plans and specifications for the same shall have been submitted to the commissioner of education and his approval endorsed thereon. Such plans and specifications shall show in detail the ventilation, heating and lighting of such buildings. Such commissioner of education shall not approve any plans for the erection of any school building or addition thereto unles the same shall provide at least fifteen square feet of floor space and two hundred cubic feet of air space for each pupil to be accommodated in each study or recitation room therein, and no such plans shall be approved by him unless provision is made therein for assuring at least thirty cubic feet of pure air every minute per pupil, and the facilities for exhausting the foul or vitiated air therein shall be positive and independent of atmospheric changes. No tax voted by a district meeting or other competent authority in any such city, village or school district, exceeding the sum of five hundred dollars, shall be levied by the trustees until the commissioner of education shall certify that the plans and specifications for the same comply with the provisions of this act. All school houses for which plans and detailed statements shall be filed and approved, as required by this act, shall have all halls, doors, stairways, seats, passage ways and aisles and all lighting and heating appliances and apparatus arranged to facilitate egress in cases of fire or accident and to afford the requisite and proper accommodations for public protection in such cases. All exit doors shall open outwardly, and shall, if double doors be used, fasten with movable bolts operated simultaneously by one handle from the inner face of the door. No staircase shall be constructed with wider steps in lieu of a platform but shall be constructed with straight runs, changes in direction being made by platforms. No doors shall open immediately upon a flight of stairs, but a landing at least the width of the door shall be provided between such stairs and such doorway.

2. This act shall take effect immediately.

Steamfitting Class, New York Trade School

The New York Trade School started its day class for steam fitting work, January 4, the following being the membership:

Benj. S. Bacon, Waterloo, N. Y.
Jay E. Bain, Petoskey, Mich.
Clarence A. Bogardus, Ithaca, N. Y.
Edw. S. Cleland, Meaford, Ont.
Jas. G. Duppen, Brooklyn, N. Y.
Edwin Ferrier, Paterson, N. J.
Herman Fieber, Brooklyn, N. Y.
Alex. G. Forsythe, Lowell, Mass.
Henry W. Green, Edgerton, Ohio.
Harry L. Hogg, Riverhead, N. Y.
Harry Jacobus, Glen View, N. J.
Louis W. Kamp, Mt. Carmel, Ill.
Frank J. Larkin, New York City.
John J. Meskell, Meriden, Conn.
Charles W. Miller, Milwaukee, Wis.
John J. Murphy, West New York, N. J.
Harry M. Nacey, Chicago, Ill.
Ernest E. Pritts, Somerset, Pa.
Walter P. Renker, Jersey City, N. J.
Galen R. Ulsh, Lykens, Pa.
Arthur R. Vogel, Bethlehem, Pa.
Lorne B. Walrond, Petoskey, Mich.
Clyde T. Weaver, Bethlehem, Pa.
Wm. Widdicombe, Chicago, Ill.

The course lasts until April 5, and comprises practical work in setting up boilers, running pipes, connecting up radiators and other appliances. There will also be a course of lectures explaining the principles which underlie the work. The course also includes instruction in the use of drafting instruments and making complete detailed plans for heating jobs.

The Situation in the New York Building Trade

From present indications it would seem that before May 1, 1905, there will be in existence in New York city and vicinity the largest and most important organizations of both employers and workmen in the building trades that have ever been established in any locality. At a meeting of the unions held this week it was announced that 38 labor organizations directly connected with the building trades have joined the new Associated Building Trades, which is the title of the central organization now in course

of formation. It is stated that more than 80,000 workmen are represented in the new body, which is designed to embrace delegates from all labor unions whose membership is engaged in building, including both skilled and unskilled labor.

Following this movement comes the announcement that all of the building trades employers' associations in Manhattan and the Bronx, Brooklyn, Long Island City and other localities adjacent to New York city ,including possibly Jersey City, Newark and some of the towns in New Jersey and Connecticut located within a radius of 25 miles of the City Hall, New York, are preparing for a general amalgamation, which will take in practically all of the employing and contracting firms and individual employers in the building industry in this section. Recently, P. K. Stephenson, who was formerly connected with the Employers' Association, of Pittsburg, Pa., has been made secretary of the New York Building Trades Employers' Association, with the view of taking charge of the active work of the proposed larger organization.

Whether the outcome of the formation of these two important bodies will tend toward peace or war in the building trades next year is a matter which it is impossible to foretell at the present time. The declared policy of the leaders of the new central labor organization is to break down the arbitration plan under which a number of the labor unions are now working in harmony with the Employers' Association in New York city. This plan has worked well in many respects and the employers are satisfied with its operation, but the claim is made, on the part of some of the dissatisfied unions, that the advantages gained by the plan are all on the side of the employers. Their declared object is not to antagonize the principle of arbitration, but to so modify the present system that, from their point of view, it will work more equitably to both parties. The question of the "open shop," which is a burning one with most of the other associations of employers throughout the country, enters little, if at all, into the situation in New York. The officials of the Employers' Association have announced that there is no thought or intention of forcing the "open shop" in the New York building industry. Owing to the peculiar conditions which exist in the city and vicinity, the "open shop," they say, is neither practicable nor desirable, so far as the building industry is concerned.

The situation is an interesting one and the progress of the movements on both sides will be watched with great interest by those who are directly or indirectly interested in the building industry, as well as by the public at large. Should a struggle eventuate, it would probably be one of the most serious conflicts that has as yet occurred in this important industry. Millions of dollars of capital will depend upon the attitude which the two organizations assume. It is to be hoped that a modus vivendi will be reached whereby harmonious relations between labor and capital may be established in the building industry for the coming year, for 1905 promises to see a remarkable degree of building activity in New York city and its neighborhood, and any interruption of this activity through strikes or lockouts would be deplorable in its effects upon business at large.—*Metal Worker.*

Practical Hints on Advertising

Some advertisers find it impossible to get any enjoyment out of their meals because some competitor is worrying them. It is generally some larger house that has made a success by judicious advertising, and its rivals can never forgive it for being so prosperous.

The larger house was a small house, too, once upon a time—but the right sort of inside management and outside publicity started it along the road to success.

It may seem that the larger house has the field pretty well covered and cannot be successfully contended with.

This is the worst kind of a fallacy.

It is the excuse of the man who thinks that other people are holding him down.

As a matter of fact, nothing is holding him down but his own failure to properly utilize the most valuable of all business ammunition—advertising.

There are some reasons why he can serve customers better than the other house, or the other house would have all the trade. Let him present these reasons forcibly and pertinently, and it won't be long before his increased business will keep him too busy to worry about competition.—*Trade Press List.*

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

ELECTION OF OFFICERS

The report of the tellers showed the following officers elected for the ensuing year:

President, Wm. Kent;
First Vice-President, R. P. Bolton;
Second Vice-President, C. B. J. Snyder;
Secretary, W. M. Mackay;
Treasurer, U. G. Scollay;
Board of Governors:
B. H. Carpenter.
B. F. Stangland.
Jas. Mackay.
A. B. Franklin.
J. C. F. Trachsel.

TRADE AND MISCELLANEOUS NOTES

CHARLES M. WILKES died in Philadelphia, January 7. Mr. Wilkes was born in 1858 at Manchester, Conn., and was a graduate of the Massachusetts Institution of Technology. From 1881 to 1884 he was constructing engineer for the city of Boston; from 1884 to 1899, constructing engineer for the city of St. Paul; from 1889 to 1891, engineer for the Chicago Union Transfer Railway; from 1891 to 1893, assistant engineer of Water Supply and Drainage for the World's Fair at Chicago. Since that time he has been connected with D. H. Burnham, the Chicago architect, having special charge of the heating, ventilating and plumbing.

Mr. Wilkes was an interested member of the American Society of Heating and Ventilating Engineers, which he joined in 1897.

ALEXANDER B. HAY, Chicago, Ill., died January 3, at the age of 77. He founded the firm of Hay & Prentice, and afterward the Heating Appliance Company, of which he was president.

E. P. BANCROFT, Detroit representative of *Domestic Engineering*, died Christmas day, at the age of seventy-five.

Mr. Bancroft was a graduate of the University of Michigan Medical College and a veteran of the late war, having risen to the rank of Major of Cavalry.

JOHN WRIGHT, prominent plumber and steam fitter of Toronto, died December 10, at the age of sixty-eight.

DARK & CO., Buffalo, N. Y., have added steam and hot water heating to their large plumbing business.

W. H. TONER & CO., is a new firm at Worcester, Mass.

WEST SIDE STEAM HEATING CO., St. Paul, Minn., has filed a petition of bankruptcy.

FRAKER & CO., is a new heating and plumbing concern at Shelbyville, Ind.

INSTANTANEOUS WATER HEATER CO., Cincinnati, O., have increased their capital from $10,000 to $15,000.

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DEMAND AUTOMATIC CONTROL OF TEMPERATURE

WE SUPPLY THE DEMAND

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THE POWERS REGULATOR CO.

111 FIFTH AVENUE
NEW YORK

40 DEARBORN ST.
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CULM HEATER CO., Camden, N. J., is a new corporation with a capital of $300,000. The incorporators are, H. K. Kriebel, O. C. Schmindt, W. F. Martin, L. S. Oliver and M. L. Barry.

WILLIAM P. SWEENEY, Claremont, N. J., has bought the heating and plumbing business of Edward A. Nayes.

PETER TESTAN, 1429 Fifth avenue, New York, has a new boiler and steamfitting shop.

FULTON CO., Knoxville, Tenn., incorporated with a capital of $50,000 for the manufacture of a heat regulating device for hot water, steam and hot air house heating.

EAU CLAIRE CORNICE & HEATING CO., Eau Claire, Wis., incorporated by D. J. Van Hovenberg, E. Stockwell and H. G. Helstron with a capital of $25,000 to do heating, plumbing and cornice work.

H. P. FULTON, Marshall, Minn., has purchased the stock of goods and tools of the Reinhardt Heating & Plumbing Co.

U. S. RADIATOR CO., Dunkirk, N. Y., have opened a branch office at Washington street and Ninth avenue, South Minneapolis, Minn.

LIPPINCOTT STEAM SPECIALTY & SUPPLY CO., Newark, N. J., has been incorporated by A. C. Lippincott, H. Meyer and S. J. Cox, with a capital of $20,000.

FIEBEGER HEATING CO., Akron, Ohio, has been incorporated by Frank Fiebeger, C. J. Benner, H. J. Hough, Frank Nolte and Grace M. Fiebeger, with a capital stock of $50,000, to make heating apparatus.

YOUNGSTOWN FURNACE & SUPPLY CO., Youngstown, Ohio., has been incorporated by Leon Geschwind, F. G. Jennings, Alvin Rice, Fred Mattmueller and L. H Young, with a capital of $50,000.

M. L. Parker Co., Freeport, Ill., has been incorporated for the manufacture of heating supplies, by M. L. Parker, J. F. Marion and L. L. Conter, with a capital of $5,000.

MILWAUKEE HEATER MFG. CO., Milwaukee, Wis., has been incorporated by George Linder, H. J. Rock and John Reid, with a capital stock of $20,000.

KUHNLEY PLUMBING & HEATING CO., Rockville, Conn., succeed Kuhnley & Pritcher.

SHIRLEY RADIATORS

"Please the Eye and Heat the Room"

Ask Your Jobber for Prices

If you don't get what you want, write us direct

We Make the Goods and the Prices

Shirley Radiator and Foundry Co.

Factory, Shirley, Ind. **INDIANAPOLIS, IND.**

UTICA HEATER CO., Utica, N. Y., have started for this year, a monthly calendar to be sent to the trade advertising their boilers and furnaces.

THE MODEL BOILER VALVE TOOL for everyone who does any pipe work is advertised by a postal card of the Model Heating Co., 142 N. Tenth street, Philadelphia.

This concern has put upon the market a special wrench for making up radiator valves which does not mar the valve and leaves the job in excellent condition.

Every heating contractor should have their descriptive circular and prices.

GURNEY HEATER MFG. CO., Boston, send their compliments for the new year in the shape of a handsome card bearing the monogram of the company embossed in gold.

PIERCE radiator and air valves are manufactured by the Pierce, Butler & Pierce Mfg. Co., Syracuse, N. Y., who describe them in a little catalogue. The "Royal" and "Pierce" valves have been known to the trade for years. In addition to these there are the "American" and "Reliance" valves.

Copies of the book will be sent on application to the manufacturers.

BLAKE & ANDROS, Boston, will shortly vacate their quarters at 28 Portland street, having hired the premises at 195 High street (Fort Hill Square), of which they expect to take possession about the first of February. This will give them about 5,000 square feet of floor space, divided into a fine store room, offices and a large and convenient storage and shipping room. This change has been made necessary by a healthy growth in business and will enable them to carry a stock in Boston to meet prompt delivery demands, and in their efforts to this end they ask the co-operation of their patrons to specify their future needs at as early a date as possible. Atlantic avenue circuit elevated is less than one minute from their new store. Get off at Boston, Revere Beach and Lynn station, remember the number, 195 High street.

J. B. BERNHARD, Well known as a manufacturer and sales manager of hot water steam house heating boilers, and for the last few years manager of the boiler department of Abendroth Bros., New York, will shortly produce a boiler of his own. He has resigned his position with Abendroth Bros., and connected himself with the Garwood Foundry &

"Sunrays" are pleasant in Winter

Why not use Sunrays in your business?

We will make it pleasant and profitable for you to use them.

The J. L. Mott Iron Works

84-90 Beekman St., New York

Machinery Co., Garwood, N. Y., of which he is secretary and general manager. His new line of boilers will be put upon the market at the earliest possible date and they will doubtless embody the excellent points natural to expect from a man of Mr. Bernhard's experience and ability.

J. H. DONNELLY, formerly with J. H. Merritt & Co., is consulting and heating engineer for Arthur McGonagle Co., 136 Liberty street, New York.

CRANE CO., Chicago, held their annual conference of branch managers, December 20.

AMERICAN RADIATOR CO., Chicago, will have the annual conference of their branch managers, January 17 and 18.

MODEL HEATING CO., New York, held their annual banquet at the Arena, December 29. All of the officers and the salesmen of the company were present.

KELLOGG - McCRUM - HOWELL CO., New York, had a meeting of their salesmen in New York on January 9. The day was occupied with discussions of business propositions and the usual comparing of notes between salesmen working different territories, which those manufacturers who have tried it know to be one of the most productive methods of expending time and money.

In the evening dinner was served at the Arena, at which the following were present: C. V. Kellogg, President; W. J. Furnee, Vice-President; L. G. McCrum, Treasurer; H. T. Gates, Secretary; H. S. Gardner; H. C. Adams, J. L. Greenman, and the following of the selling force: A. H. Pearson, Philadelphia; William Grier, Boston; T. C. Fleming, New York State; L. A. Lanigan, Ohio; G. F. Green, Brooklyn; F. A. Leland, Vermont; J. A. B. A. Ammon, Pennsylvania; F. D. Gosman, Baltimore; F. P. Bassett, Jr., Kentucky; J. F. Johnston, Rhode Island; R. J. McGuire, western New York; W. H. Smith, New York city; J. S. Comrad, Philadelphia; J. T. Carney, New York.

At the conclusion of the dinner, President Kellogg was genuinely surprised by the presentation of a handsome gold watch from Tiffany's bearing his monogram and on the inside the inscription: "Presented to C. V. Kellogg by the salesmen of the Kellogg-McCrum-Howell Co., January 9. 1905." The presentation speech was made by Mr. Gardner. Treasurer McCrum also made a few remarks.

After dinner the party went to Wal-

THE ÆOLIPYLE

When applied to the Smoke Collar of a Furnace

SAVES Time, Labor, Coal.

PREVENTS Escape of Coal Gas.

GIVES Additional Heat and an even Temperature night and day.

Recommended by Furnace men. Specified by Architects. Adopted by the United States Government.

In use by thousands of individuals, as well as Railroads and School Boards.

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***ÆOLIPYLE CO.,* 237 Water St., NEW YORK.**

lack's Theater and afterward amused themselves as well as they could in a dismal town like New York.

E. H. HOBBY, New York manager of W. A. Russell & Co., met with a combination ice and trolley accident January 10, which temporarily disabled him. He made a pretty fast recovery, but when he gets to his desk he is all right for business and has a good working knowledge of the malovelence of the famous Brooklyn Rapid Transit System.

JOHN SIMMONS CO., 110 Centre street, New York, have found it necessary to entirely overhaul their premises in order to enable them to comfortably handle their large and increasing business. They have had to remove their accounting force to the second floor, the first floor being divided up into handsome and convenient quarters for the officers and their assistants.

THOMAS C. CRONE, well-known heating man in the East for many years, but of late Chicago manager for the U. S. Heater Co., is moving toward home, having connected himself with the International Heater Co., Utica, N. Y.

HARRY M. NACEY, son and assistant of P. Nacey, Chicago, will take a course of heating and power work in the New York Trade School.

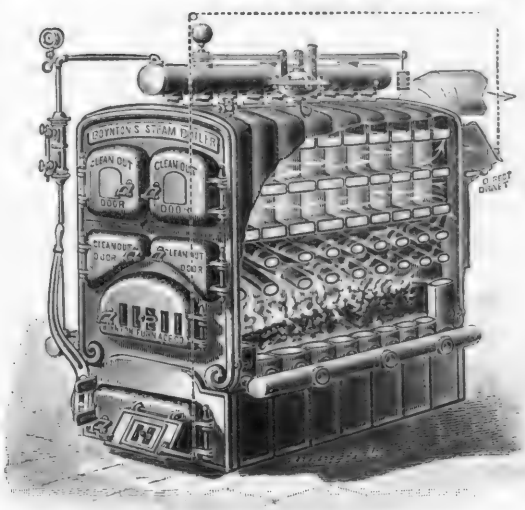
ELMIRA HEATER CO., Elmira, N. Y., will erect a plant in which to do their own manufacturing which has previously been done on contract.

CRANE CO., Chicago, whose practice it is to set aside each year a certain percentage of their profits to be distributed among their employees at Christmas, distributed this year an amount equal to ten per cent. of the salary drawn during the year by each employee, which makes a handsome Christmas present.

WM. FLANNERY, a steam fitters' walking delegate in Chicago, was stabbed the other day by one of the paperhangers' union as a consequence of an unnecessary

FUEL ECONOMY GUARANTEED
VACUUM STEAM HEATING SYSTEM
Morgan & Co. Chicago.

The Boynton Steam Boilers and Hot Water Heaters



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10 Post Office Square BOSTON
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quarrel worked up between them by a third party.

C. W. RUGG, formerly with the A. A. Griffing Iron Co. and later with the Gurney Heater Co., has taken charge of the heating department of the Thomas Hoey Mfg. and Supply Co., Boston.

WM. L. MITCHELL, JR., of Wm. Mitchell & Co., 1 Province Court, Boston, has been appointed aide-de-camp with the rank of Major, on the staff of Governor Douglass.

Heating Contracts

HENRY N. CLARK CO., 56 Union street, Boston, heating new apartment house at Somerville.

LEWIS & KITCHEN, Topeka, Kas., heating and ventilating new High School at Little Rock, Ark.

E. W. WEBSTER, Du Bois, Pa., heating and plumbing Methodist Church at Clearfield, Pa.

MATTISON BROS., Brookville, Pa., heating and plumbing Odd Fellows' Hall, Reynoldsville, Pa.

MATTISON BROS., Brookville, Pa., heating and plumbing First National Bank, Reynoldsville, Pa.

SMITH & STREBEL, Monroe, N. Y., heating M. E. Church, at Turners.

W. O. HOLMES & SON, Bloomsburg, Pa., remodeling heating system for Magee Carpet Mills.

MULLER & VULTEE, 9 N. Moore street, New York, heating loft building at 44 E. Fourteenth street.

FOSTER HEATING CO., 15 Palmer street, Roxbury, Mass., new building for the Brewster Free Academy at Wolfboro, N. H.

A. B. FRANKLIN, 165 Fort Hill Square, Boston, Mass., heating residence of W. H. Moore.

J. E. DONOVAN, 177 W. Twenty-sixth street, New York, heating row of flats at 129th street.

MARSH & OLDACRE, 1717 Chestnut street, Philadelphia, heating large residence in Pittsburg.

J. M. PRUTZMAN, Birdsboro, Pa., heating new Union Hall.

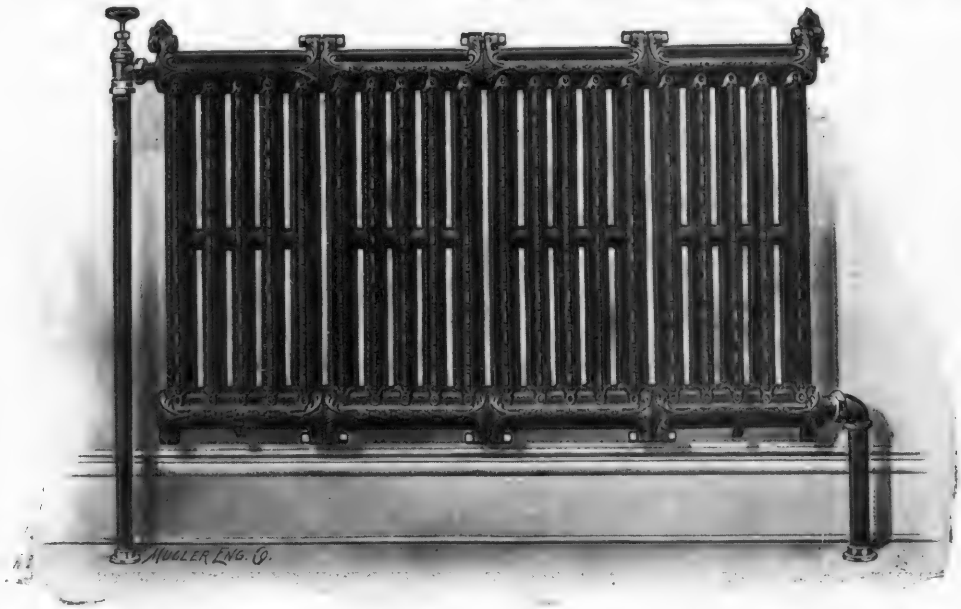
GULICK & WETHERBEE, San Francisco, heating building on Ellis street.

LEWIS & KITCHEN, Topeka, Kas., heating new First Baptist Church.

SPRINGFIELD PLUMBING CO., Springfield, Mo., heating and plumbing new government building at Harrisonville, Ark.

"Novus" Wall Radiator

PATENTED



Slip Nipple Connections Consequent freedom from leaks when many sections are combined in one radiator. Easily assembled without special tools. **Artistic in Appearance**

National Radiator Company, Johnstown, Penn.

CHAS. B. KRUSE HEATING CO., Milwaukee, Wis., heating new Fourteenth Ward School.

WILLIAM J. McGUIRE, Mamaroneck, N. Y., heating residence at Rye Neck.

FIFE BROS., Canton, O., heating new infirmary building.

ALEX. DUNCAN & CO., Boston, heating the Church of the Epiphany at Winchester.

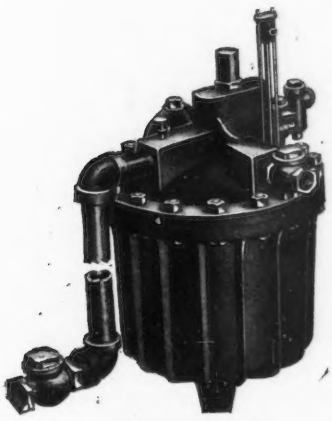
JOHN I. DICK, Scottsdale, Pa., heating and plumbing large apartment house at Mt. Pleasant, Pa.

SCHNEIDER PLUMBING CO., 570 Euclid avenue, Cleveland, O., heating and plumbing Flynn apartment house.

DETTELBACH PLUMBING & HEATING CO., 509 Woodland avenue, Cleveland, O., heating and plumbing lodging house of H. M. Strong.

W. F. WILSON CO., San Francisco, Cal., heating and plumbing building for Pope Estate Co.

J. W. HUNT & CO., 24 Chestnut street, Providence, R. I., heating new building at Uxbridge, Mass., for the New York, New Haven & Hartford R. R. Co.



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WILLIAM WARREN, Painted Post, N. Y., heating bakery on William street, Corning, N. Y.

DICKINSON HEATING & VENTILATING CO., Peoria, Ill., heating and ventilating new Willitas school, Monmouth, Ill.

C. A. CRIQUI, 926 Main Street, Buffalo, N. Y., heating Larkin soap works, Senaca street.

JENNISON PLUMBING CO., Fitchburg, Mass., heating new high school building.

FRANK CARROLL, Roscoe, N. Y., heating and plumbing the Phelps cottage, Horton, N. Y.

BUCKEYE HEATING & SUPPLY CO., 3 Court Place, Cleveland, O., heating residence of Homer B. Knapp, Painesville, O.

SAWYER & DEAN, Dedham, Mass., heating and plumbing residence of Geo. F. Washburn.

BLAKE & WILLIAMS, 211 W. Twentieth street, New York, heating and ventilating new buildings of the College of the City of New York.

MULLER & VULTEE, 9 N. Moore street, New York, heating loft building at Broadway and White street.

EMPIRE HEATING CO., 4177 Third avenue, New York, heating flats at 171st street.

PETER CUNNEEN, New Rochelle, N. Y., heating and plumbing houses for Frank Holler.

JOHN D. CLARK'S SON & O'DONNELL, 276 Water street, New York, heating new Williamsburg Trust building in Brooklyn.

MANGRUM & OTTER, San Francisco, Cal., heating six-story building for D. L. Randolph on Mason street.

SCHUSTER & WILLIAMS, Lincoln, Ill., heating and plumbing new Gillette Block.

J. A. MONTGOMERY, San Francisco, Cal., heating Hedrick Theater at Astoria.

M. J. DALY & SON, Waterbury, Conn., heating fire-engine house.

H. A. DUSTIN & CO., Kewanee, Ill., heating new high school, using American radiators.

ROBBINS & GAMWELL, Pittsfield, Mass., steam heating Hoosac Valley Street Railway's barns, Adams, Mass.

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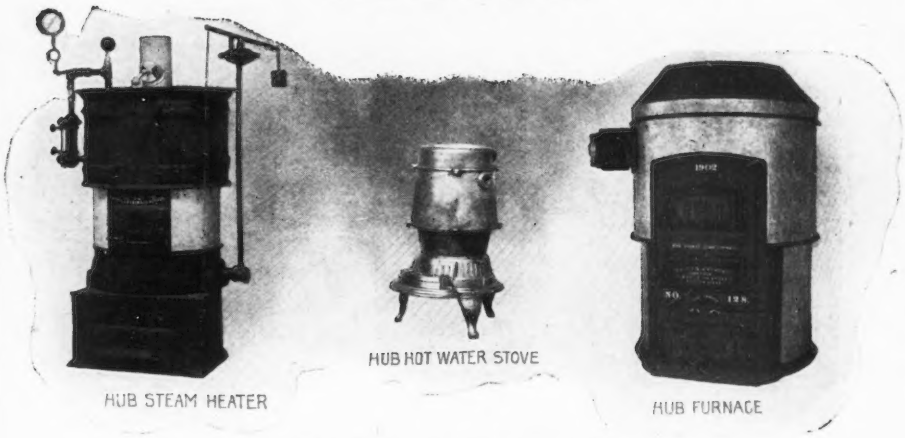

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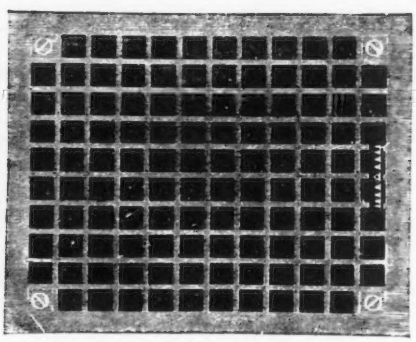

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